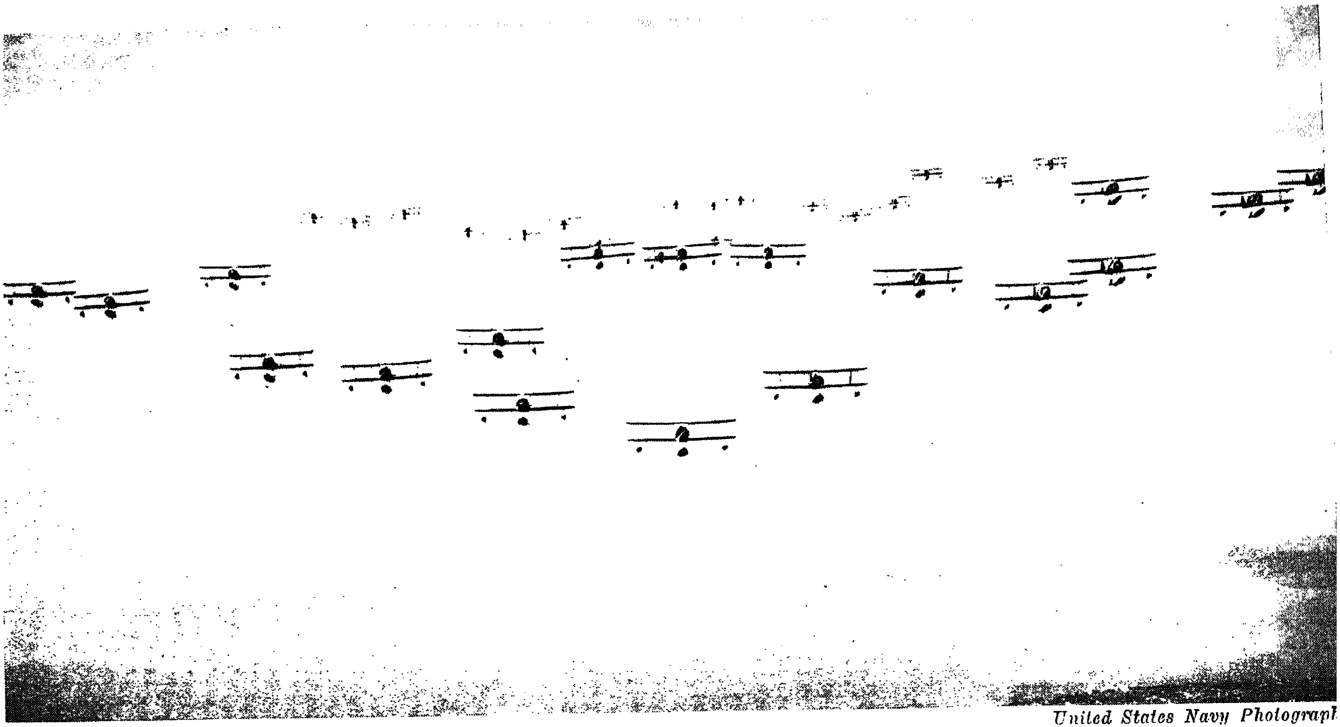
SEAPLANES

Maneuvering, Maintaining, Operating



United States Navy Photograph

"THE EYES OF THE NAVY"

SEAPLANES

Maneuvering, Maintaining, Operating

by

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TO

D. J. B., Sr.

FOREWORD

It is a real pleasure to write an introduction for Dan Brimm, because he has contributed a great deal to water flying and his subject is one that lies very close to my heart.

His story is written in simple, nontechnical style and springs from a fund of unusually well-rounded knowledge, for he has lived with his work from every possible angle—as engineer and designer of flying boats and amphibians; as barnstorming seaplane pilot; as operator of a seaplane school and charter service; as professional test pilot; and as aviation instructor.

I am glad he has told this story, and I am sure it will prove helpful to those landplane pilots who have not yet had the fun of getting their feet wet!

George B. Post

Chairman
Marine Air Terminals Committee
Aeronautical Chamber of Commerce of America

PREFACE

The development of seaplane flying, except in the Navy, has been rather slow. There are several reasons for this. One is, that while there were many government-surplus landplanes available at low cost after the war, there were few seaplanes of any value for commercial work; hence most of the flying was confined to land operation. Another reason is that many small companies undertook the manufacture of landplanes as the war-surplus ships were used up, but very few made any efforts toward float or flying boat construction. A third retarding factor in respect to water flying has been the dearth of suitable bases.

It is safe to say that the large majority of those who have become acquainted with seaplanes greatly prefer them to the land types. The seaplane is safer, in many cases is a much quicker means of transportation, as will be shown later, and certainly affords greater sport. Floats may now be purchased and installed on practically any standard landplane; amphibious floats are available in certain sizes; and several companies are entering the market with amphibians of the flying boat type. The number of seaplane bases is increasing rapidly, partly through the efforts of the Government, so that in any but the most out-of-the-way localities, at least gas and oil are available, and they are, of course, the most important requirements. Accordingly, the trend toward water flying is marked, and as more and more pilots and passengers become acquainted with its pleasures, its many conveniences, and, above all, its extreme safety, there seems no doubt that this trend will become even more pronounced.

This book has been prepared as a guide for those land pilots who wish to feel at ease on the water, for the seaplane student who has not yet found his wings, for the commercial operator who is planning seaplane activity, and for the private owner or prospective owner of a seaplane. While the volume is not a mechanic's handbook, sufficient information is included to enable anyone with reasonable mechanical aptitude to make any ordi-

nary repairs. Likewise, while it is not written for engineers, the salient principles involved in seaplane design are explained in nontechnical terms. Again, though it is obviously beyond the scope of the work to supply working drawings of all the various types and sizes of ramps and bases, an effort has been made to give the private owner or a municipality some idea of the problems involved, together with possible solutions.

Colloquialisms, such as "ship" for "airplane," "gun" for "open the throttle," and similar expressions, have been freely employed, both to make the pilot feel at home and to acquaint the student with the language of the field.

Grateful acknowledgment is made to George B. Post for his helpful criticism and suggestions, which have added greatly to any merit the work may claim. The author is also indebted to the Edo Aircraft Corporation for the illustrations of the twin-float seaplanes, except the Macchi-Castoldi, and for other valuable assistance; to Chance Vought Aircraft for the photographs of single-float seaplanes; and to Fleetwings, Incorporated, for the views of their "Seabird" amphibian.

D. J. Brimm, Jr.

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Chapter I

TYPES OF WATER AIRCRAFT

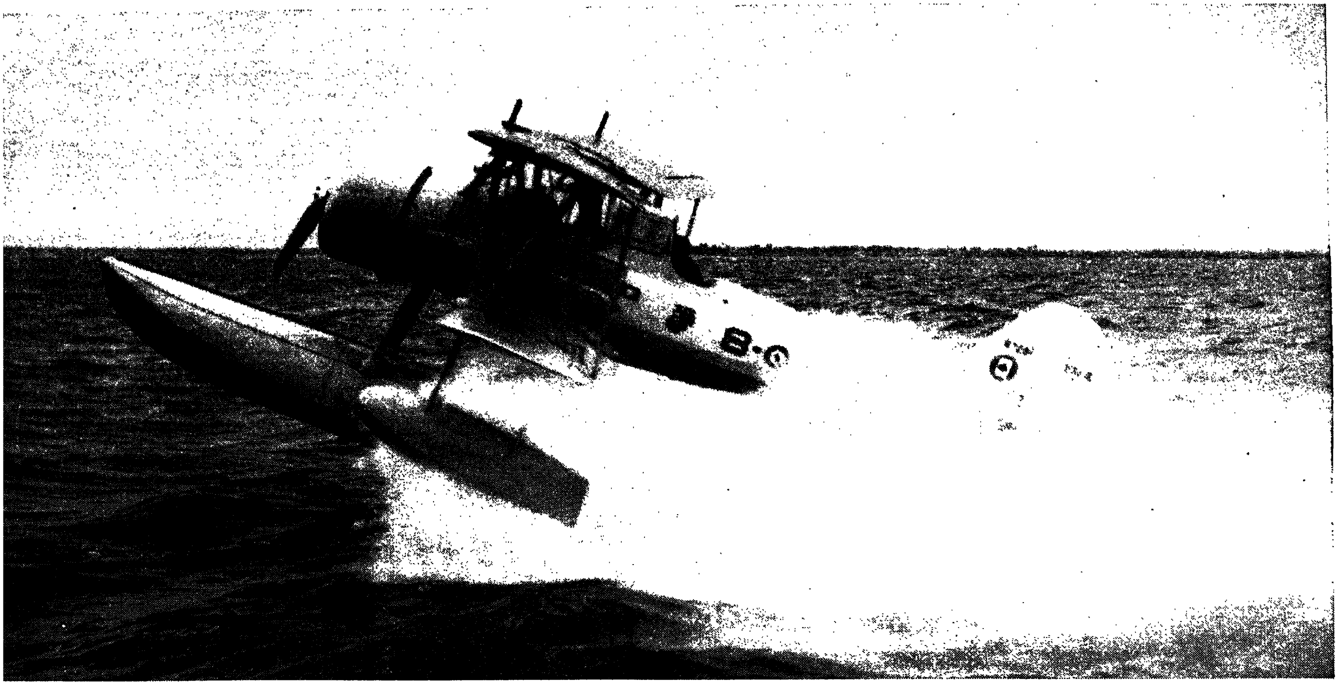
The term "seaplane" is defined by the National Advisory Committee for Aeronautics as "an airplane designed to rise from and light on the water." Specifically, however, the word is used, and will be so employed in the following pages, in referring to an airplane of more or less conventional design which, instead of having a wheel landing gear, is equipped with floats intended primarily to supply the necessary buoyancy or support on the water. Distinct from this type is the "flying boat" in which the hull, while providing flotation, also carries within itself the crew, passengers, and other useful loads.

Unless the reader is thoroughly familiar with the language of aviation and especially with that which pertains to water operation, he is urged to read the glossary supplied in the back of this volume before proceeding further with the text.

Seaplanes

Seaplanes are ordinarily of two general types, the *single-float* (illustrated in Figure 1) and the *twin-float* (shown in Figure 2), the latter being the customary design of commercial ships. The United States Navy still sticks to the *single-float* in the case of small aircraft, probably because the catapults in use were developed with this type in view. It is also believed by some authorities that one float is better in rough water than two, on account of the more direct bracing and because there is a possibility, in a heavy sea, of weaving between the individual floats when two are used.

On the other hand, practically all the naval powers, except the United States, use the *twin-float seaplane.* It is much easier to get in and out of; is stable in the water without need for wing-tip floats; may be taxied up ramps, alongside floats, or onto beaches without outside assistance; and when properly equipped



United States Navy Photograph

FIGURE 1. VOUGHT SINGLE-FLOAT SEAPLANE

Note wing-tip floats.

with water rudders is much more easily handled by a beginner, if not by an expert. Furthermore, as evidence of its all-around efficiency, this type has for years held the world's unlimited speed record. (See Figures 32 and 33.) For these and many other reasons, the single-float type is practically unknown in the commercial field, and hence will not be considered further.

Most seaplanes are simply landplanes with the wheels and other parts of the landing gear replaced by floats and their bracing. This arrangement gives the prospective purchaser a

FIGURE 2. TWIN-FLOAT SEAPLANE (MONOCOUPE)

Note action of scalloped bottom on water.

wide range of sizes, types, and prices from which to make his selection. It also makes possible the use of production methods in the manufacture of the floats, as a float of one particular size may be used on any airplane within a certain weight class. The struts and wires are different for each type of airplane and are usually designed, as far as possible, to fasten to the fittings and attachments used for the landing gear struts. The floats, however, are made with universal fittings, so that even though the struts are different no changes are necessary in the float design. Because of their efficiency and convertibility and the lower cost made possible by production manufacture, seaplanes have practically supplanted flying boats except in the very large multi-

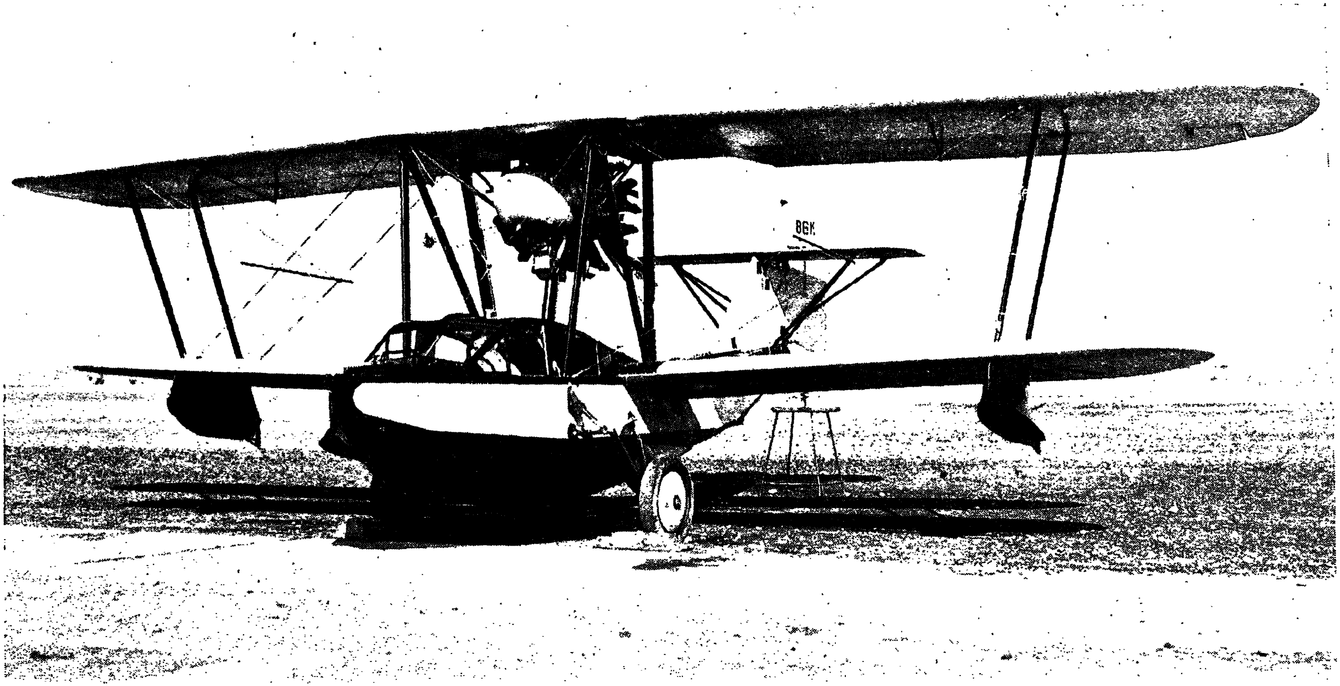


FIGURE 3. IRELAND "NEPTUNE" PUSHER AMPHIBIAN FLYING BOAT

Designed and test-flown by the author in 1927.

engine transports. There is, however, no more limit to the size of seaplanes than there is in the size of the boats. Admiral Byrd used one of the largest transport ships built at that time on his last trip to the South Pole, equipping it with floats in place of the wheel landing gear. As the floats in such a ship are usually located under the outboard engines, the propellers are almost entirely clear of spray, even in very rough water, which is not the case in many types of boats with the engines similarly located.

Flying Boats

Flying boats are divided into two general types, the *pusher* and the *tractor,* either of which may have one or more engines. Occasionally, where several engines are employed, some are used as pushers and some as tractors. A single-engine pusher is shown in Figure 3, a single-engine tractor in Figure 4, and a twin-engine tandem combination of pusher and tractor in Figure 5. A twin-engine tractor is illustrated in Figure 6. In the case of the boat with only one engine, the pusher possesses the advantage of having the bow portion unobstructed by the moving propeller. This makes it more convenient to load and handle from the bow, an important consideration since the ship is usually docked bow first. Opposed to this, the tractor design is somewhat more efficient, allows better cooling (if an air-cooled engine is used), and undoubtedly presents fewer engineering problems. The multi-engine type, of course, offers the advantage of less likelihood of forced landings, and if the engines are not in tandem, greater maneuverability on the water, since the engines on one side may be throttled and the ship turned with the others. Also, in most of the larger transports of this type, the engines are partially housed in the wing, eliminating an extra nacelle and thus improving the performance by decreasing both the weight and the resistance.

Flying boats are usually kept from turning over in the water by the use of wing-tip floats, as shown in Figures 3, 4, and 6. Occasionally, however, this purpose is accomplished by "sea wings" as used on the Dornier in Figure 5. The exponents of these sea wings claim lower weight, lower resistance, and greater safety in extremely rough water, where there is a possibility of the tip floats being knocked off.

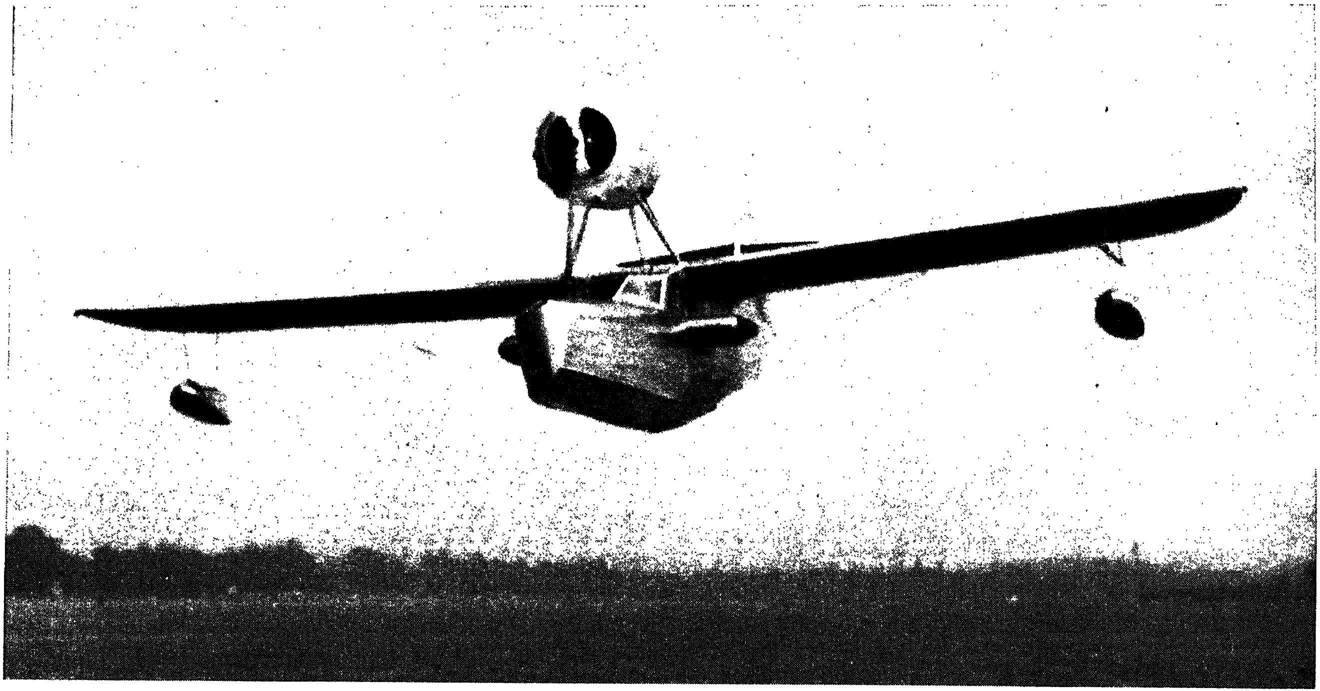


FIGURE 4. FLEETWINGS "SEABIRD" TRACTOR AMPHIBIAN FLYING BOAT

Test-flown by the author in 1936.

On the other hand, those in favor of the wing-tip floats do not concede that there is any saving of weight. Furthermore, they feel that the tip floats provide better stability when taxying in a cross wind, and that, so far as resistance is concerned, the floats may be retracted into the wing, as is done in some of the very fast flying boats. Another advantage claimed for wing-tip floats is that in the event of a landing made with one wing low, the float will throw the wing back up again. To date, the majority of flying boats, both in this country and abroad, use wing-tip floats instead of sea wings.

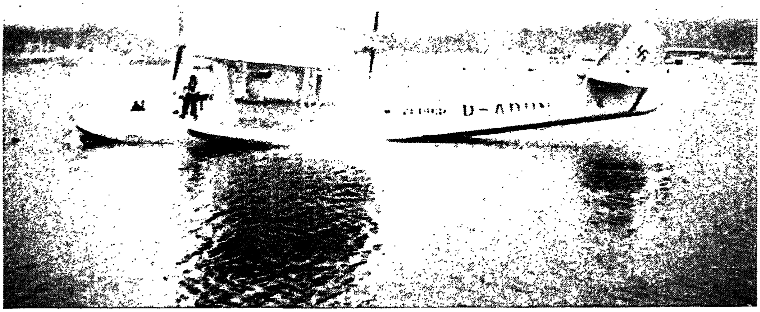


FIGURE 5. DORNIER "ZEPHIR" TRACTOR-PUSHER FLYING BOAT

AMPHIBIANS

At first glance the amphibian seems to be the ideal type of airplane, since it may be used either on airport or water, taxied out on a beach or up a ramp, and handled in a hangar without difficulty. However, it is obviously more expensive to supply both land and water utility than either one alone; hence the price of an amphibian is bound to be higher than that of a landplane or a seaplane of the same general size. It is equally obvious that since an airplane can carry only so much weight, the payload of an amphibian is bound to be less than that of an equally well-designed landplane of the same horsepower, the difference being represented by the weight of the flotation device,

whether it be hull or floats. Likewise, its payload is less than that of the equivalent seaplane by the weight of the wheels. In addition to a smaller payload, the performance of the amphibian is usually somewhat below that of other types with the same power. But if one is willing to accept these drawbacks, there is no denying the great increase in convenience and versatility.

Amphibians may be of either the boat or float type. Figure 6 shows a twin-engine amphibian boat and Figure 7, a very fast float amphibian. Floats with included amphibian gear are now being manufactured for use on standard types of landplanes also. Figures 8, 9, and 10 illustrate a set of these.

Construction

The construction of floats and hulls is of the same general type—frames and bulkheads supporting stringers to which the skin is attached. The material most commonly used is aluminum alloy, often referred to as duralumin or "dural." This material, especially when used on seaplanes or boats in the form of sheet stock, is coated on both sides with chemically pure aluminum which greatly increases its resistance to corrosion. When so coated, it is known by the trade name of *Alclad.* Wood is practically obsolete. Stainless steel has been used experimentally, and as better and less expensive methods of fabrication are developed, it may become more popular, particularly in large ships where the thickness of the sheets can be sufficient to develop the full strength of the material. The aluminum alloy is ordinarily fastened with rivets of the same material, while stainless steel is "shot-welded," this being a form of electric resistance welding in which the parts to be joined are held together and an electric current passed through them at one spot, thus fusing the pieces. By overlapping these spots, a water-tight joint is secured. Details of construction are shown in the glossary.

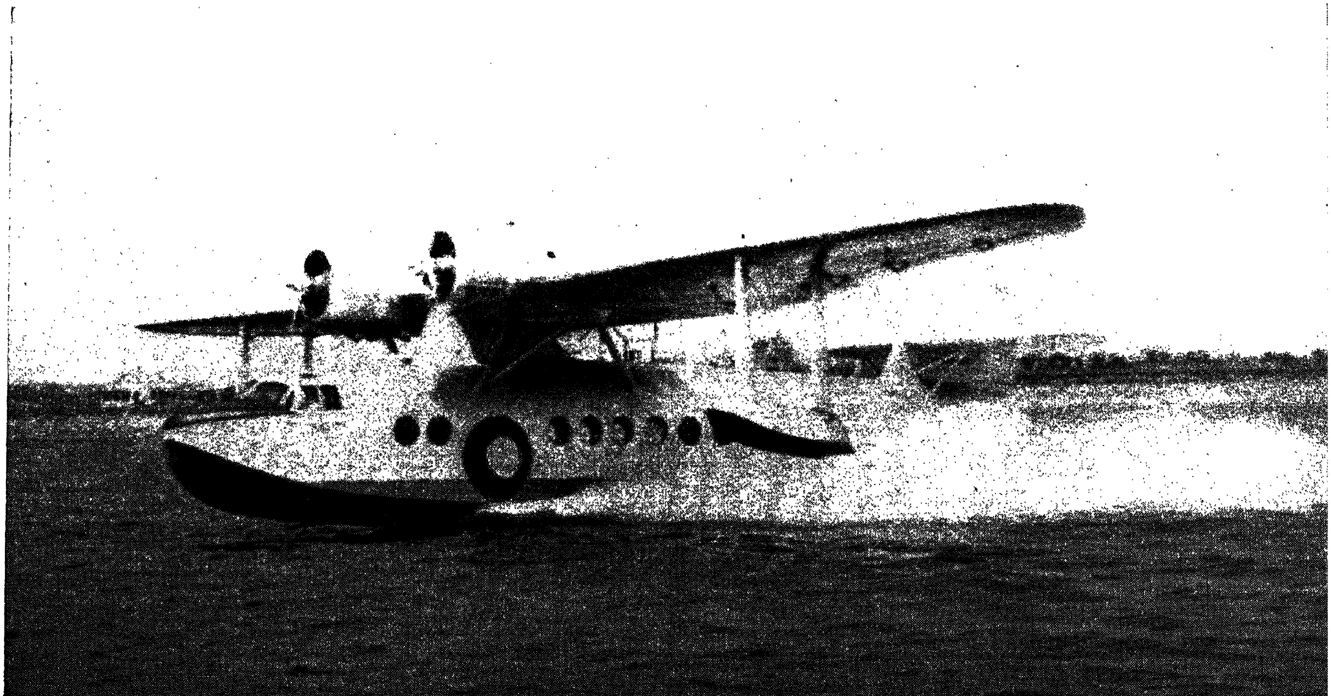
Chapter II

SEAPLANE BASES

Permanent Bases

The permanent base is considered as that type which is built on shore, with a ramp (or marine railway) suitable for getting the airplane out of the water and with or without a hangar for storage. It is the ramp proper with which this discussion is concerned, as hangars may be bought knocked down and ready to assemble, or built of customary materials and of sizes to suit conditions.

The simplest form of ramp may be constructed when there is a firm and permanent beach with a slope of about one in eight or less. In this case, for private ships of average size all that is necessary is to build a frame of two-by-eight planking spiked to six-by-six stringers, using creosoted lumber. The two-by-eight's should be as long as the width of the ramp. Twenty to twenty-five feet is enough for the ordinary seaplane or amphibian. The six-by-six's should be long enough to extend from slightly above low-water mark to a point where the depth of water at low tide is sufficient to float the ship. The stringers should be about four feet apart, depending on the weight of the ship to be carried, and the planks should be spaced half an inch to one inch apart. The spikes should be set in with a punch until they are well below the surface of the planks, as a projecting spike will rip the bottom out of a float. The whole frame should be well-weighted with scrap iron fastened *below* the planking and sunk. To the upper end of this frame another should be attached, extending above high water, and others continued on to the hangar or to a platform where the ship may be tied down. The frames above low-water mark should be fastened at the sides to piles or heavy stakes driven into the beach. The tops of these piles should, of course, be below the top surface of the planking. The ship may either be backed onto this ramp (as described later) and dragged



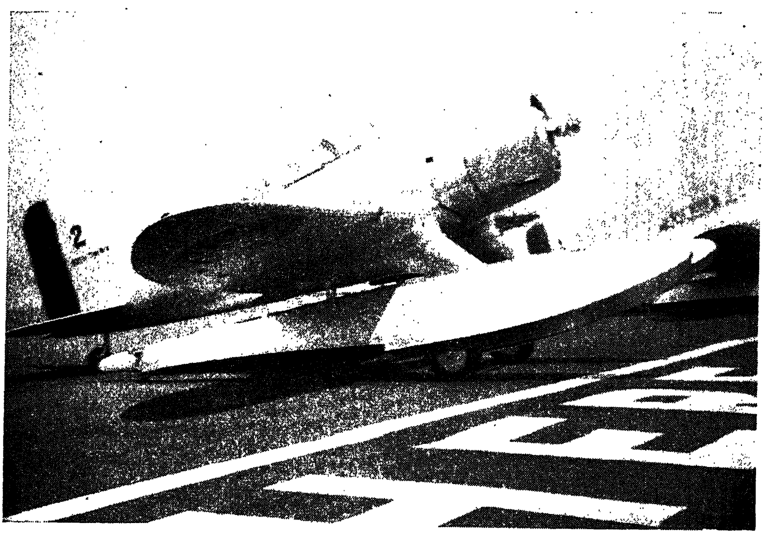
Courtesy Sikorsky Aircraft

FIGURE 6. SIKORSKY S–43 TWIN-ENGINE TRACTOR AMPHIBIAN FLYING BOAT—RUNNING "ON THE STEP"

up with a winch or tractor, or taxied up under its own power and turned around.

Figure 12 is a sketch of a ramp built for light seaplanes by a private owner on a beach which presented too irregular a surface for the type previously described, and Figure 13 is a photograph of the ramp in use. The total cost of this little base is from fifty dollars to one hundred dollars at normal prices.

The same general type of construction shown in this private ramp may be employed in building a large seaplane base. Na-



Courtesy Paul Harris

FIGURE 7. SEVERSKY TWIN-FLOAT AMPHIBIAN

turally, the larger the ships likely to be handled, the stronger the ramp must be made. It is obviously impossible to give detailed designs for all sorts of varying conditions. It is probable, however, that the wood ramp will prove highly satisfactory in any water not infested with destructive marine life. No important repairs should be necessary for eight or ten years, and then repairs may be made as the need develops without great expense.

Another type of construction, used by the Navy and by large commercial operators, is reinforced concrete. This, if properly put in, is practically everlasting, since it cannot be lifted by ice and will not rot. Unfortunately, it is impossible to skid a sea-

plane on concrete, and it is hard on the keels of floats even to touch such a ramp. In such cases the Navy puts a beaching gear or dolly (see Chapter III) on its ships while they are still afloat, and the commercial operators do the same unless amphibians are used—in which case, of course, the wheels are lowered and the ship taxied out. There is a compromise, however, which combines the good features of both wood and concrete construc-

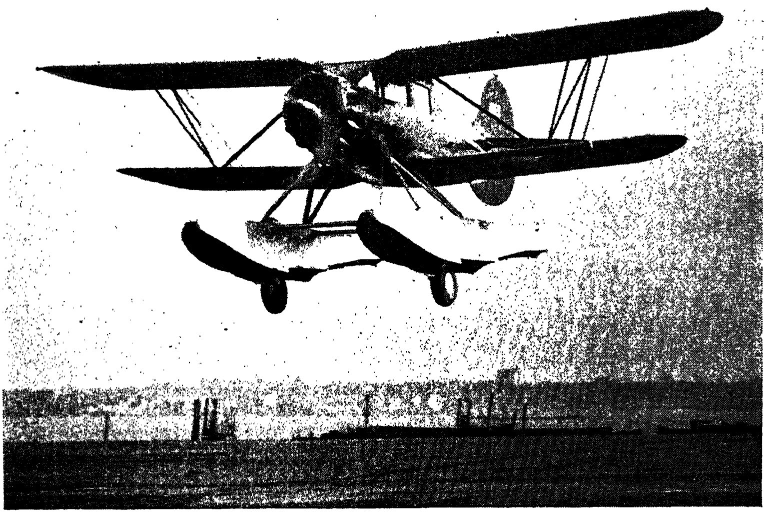


FIGURE 8. EDO AMPHIBIOUS FLOATS MOUNTED ON WACO AIRPLANE

Wheels are down for landing on land.

tions. This consists of setting two-inch planks into the concrete with a space of about two inches between them, the top surface of the plank being allowed to project about half an inch above the surface of the concrete. With such an arrangement, the solidity and permanence of the concrete is not lessened; yet a seaplane may be taxied or dragged up without damage to the floats. When the planks wear out or are attacked by marine parasites, they may be easily replaced.

A very satisfactory ramp is the turntable type designed by the Edo Aircraft Corporation and used by the New York City Skyports. This is illustrated in detail in Figure 14, and a photograph of one in use is shown in Figure 15. These bases are float-

ing, and the outer end may be raised or lowered quickly by the use of ballast tanks. The tanks are filled with water, of course, to sink the ramp, and the water is forced out by compressed air when raising. The turntable is used to rotate the ship and put it in the proper position for launching. Full instructions for pilots in the use of all types of ramps and bases are given in Chapter VII.

The marine railway type of ramp may be made small and inexpensive for the private owner or as large as circumstances

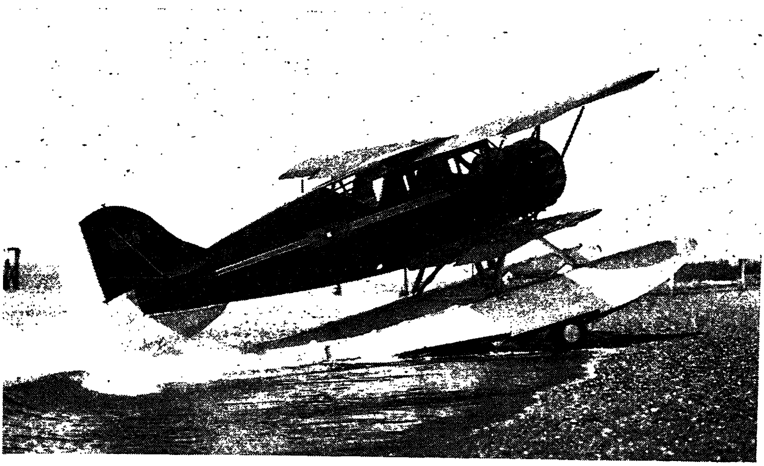


Figure 9. Taxying Out on Beach with Edo Amphibious Floats

demand. One kind, known as the "Boston" type because of its use in that city, is shown in Figure 17. A wheeled carriage, weighted so that it will sink, is rolled into the water until its upper edge is just above the surface. The ship is taxied onto the carriage, which is then pulled out of the water with a tractor or winch. Naturally, the effort required to pull out is lessened if the pilot keeps his throttle partly open. The set-up shown is not strictly a marine railway, however, as the ramp is of normal construction though rather steep, and may be used by an amphibian without the cradle or carriage. Figure 18 is a photo of the Boston dolly in use.

The true marine railway is exactly what its name implies. It consists of rails—ordinary railroad rails are quite satisfactory—mounted on trestles or on the bottom (if it is smooth

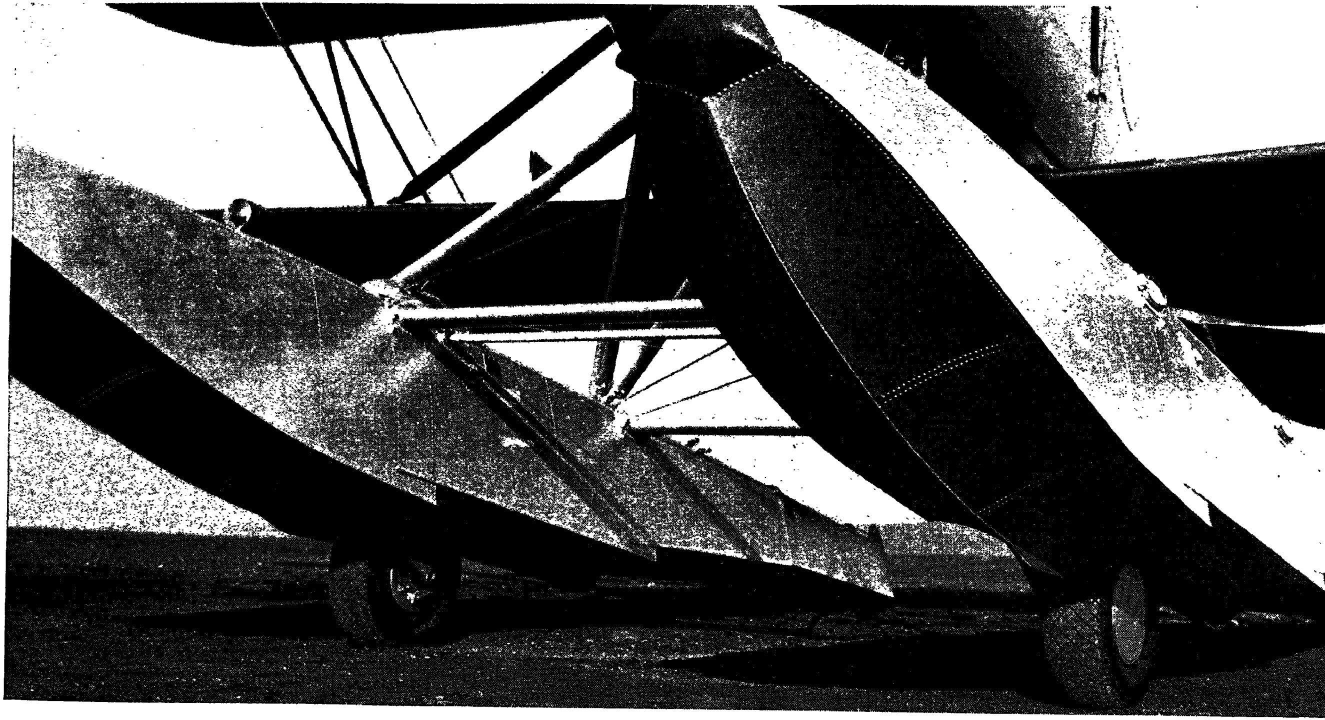


Figure 10. Close-up of Edo Amphibious Floats

enough), extending the proper distance below low water. If laid on the bottom, the rails may be bolted to cross ties on shore and carried out and sunk in the proper location. A carriage with wheels to fit the rails is then rolled out and the ship taxied onto it. After the carriage has been dragged up by winch or tractor, the ship is transferred to some sort of beaching gear or dolly. Such a device has been in use for years at Essington, Pennsylvania. It subjects the seaplane to less abuse than any other type of ramp or landing arrangement. ("Landing" refers here to getting the ship out of the water.) It is inexpensive, simple, and lasting, and is recommended as being highly satisfactory in every respect. (See Figures 19, 20, and 21.)

The floating base is a type which has been used with success in a number of cases. It is permanent, as regards construction, but not necessarily in location. It usually consists of a barge which has outlived its usefulness as such, but which is still good enough to be cut down and roofed over to provide a small hangar. If only one ship is to be stored, the barge may be loaded with ballast until its deck is only a few feet above the water and a runway or short ramp built on each side. This makes it possible to bring the ship up one side and down the other, thus eliminating any need for turning the plane around. Or one end of the barge may be sunk until it is below the surface and the ship taxied right up the deck. If it is desired to accommodate several ships, a barge of the proper size may be secured and turned into a regular floating hangar. Such an arrangement is shown in Figure 22. It has the advantage of a certain amount of mobility and may be shifted from one location to another if the occasion arises.

Semi-Permanent Bases

To avoid confusion, the term *raft* will be used throughout this book to designate a floating landing stage or disembarking platform. Ordinarily, the word used would be "float," but obviously this might cause complications since the flotation gear of a seaplane is also called a float. The point is brought up because to many readers a raft is thought of as something small, flimsy, and unstable, whereas those used for seaplane bases are often thirty to fifty feet long and ten to fifteen feet wide, and are almost as solid and stable as a pier or dock. A raft makes an excellent de-

vice for loading and unloading seaplanes, though sometimes not so handy as a ramp in the case of amphibians. The raft may be of almost any shape, but the L-shape offers many advantages where several ships are being used. If built along these lines one end of the "L" should be in contact with the dock or shore and the raft held in place with several anchors or moorings. The mooring lines will, of course, slack off when the tide runs out, but unless there is an excessive rise and fall, the change of position due to this slackening will amount to little. The sides of the raft should be well padded to prevent damage to floats and hulls. Worn out tires make excellent buffers. Mooring cleats should be provided also at intervals of eight or ten feet.

A diagram of a raft attached to a pier is shown in Figure 23, while Figure 24 is a photograph of such a raft in use. These illustrations show clearly the ease and convenience with which cargo or passengers may be loaded or unloaded. Rafts of this type may be built very inexpensively and quickly by using empty steel drums for flotation and constructing a suitable frame around them. The drums should be well-sealed and thoroughly painted with red lead or other corrosion-resistant paint. The number of drums used naturally depends on the size of the raft. One fifty gallon drum will support about 400 lbs., including its own weight. A raft and gangway large enough to handle any average ship can be built for three hundred dollars or less, and it is a very desirable adjunct to any type of base. Even though a ramp is available, unless the ship is being brought in for the night, it is much more convenient to tie it up to a float. But in the case of simply dropping off or picking up passengers, it is a nuisance to have to taxi up a ramp and turn around to get back into the water.

Docks and piers without a raft are satisfactory only if they are low enough to clear the wings and if there is no tide to speak of. In the latter case, they are in effect the same as a raft, except that they are more solid and, hence, more reassuring to nervous passengers.

Beaches may be used if they are free from rocks and slope steeply, but the abrasive effect of the sand necessitates frequent repainting of the bottom. The proper technique in beaching and docking is discussed further in Chapter VII—Approach and Departure.

Any base, whether permanent or temporary, should have some sort of fueling facilities. Anyone who has attempted to perch on the top of the wing in a choppy sea and pour gas into the tanks from a five gallon can will give forth a hearty "Amen" to this statement. Permanent bases should naturally be equipped with proper pumps and a long hose. Where this is not feasible, however, an excellent arrangement is to mount a tank of several hundred gallons capacity on a frame higher than the top wing of any ship likely to be serviced. This tank may be filled from the tank-wagon which supplies the fuel, or, if received in drums, it may be pumped up when convenient. A hose from the bottom of the tank allows the fuel to flow into the ship by gravity.

Before building a base, the nature of the shore, the prevailing winds, the approaches, obstructions, and general characteristics of the locality should be studied thoroughly and, if possible, competent advice secured. A number of construction concerns now have special departments for this work.

CHAPTER III

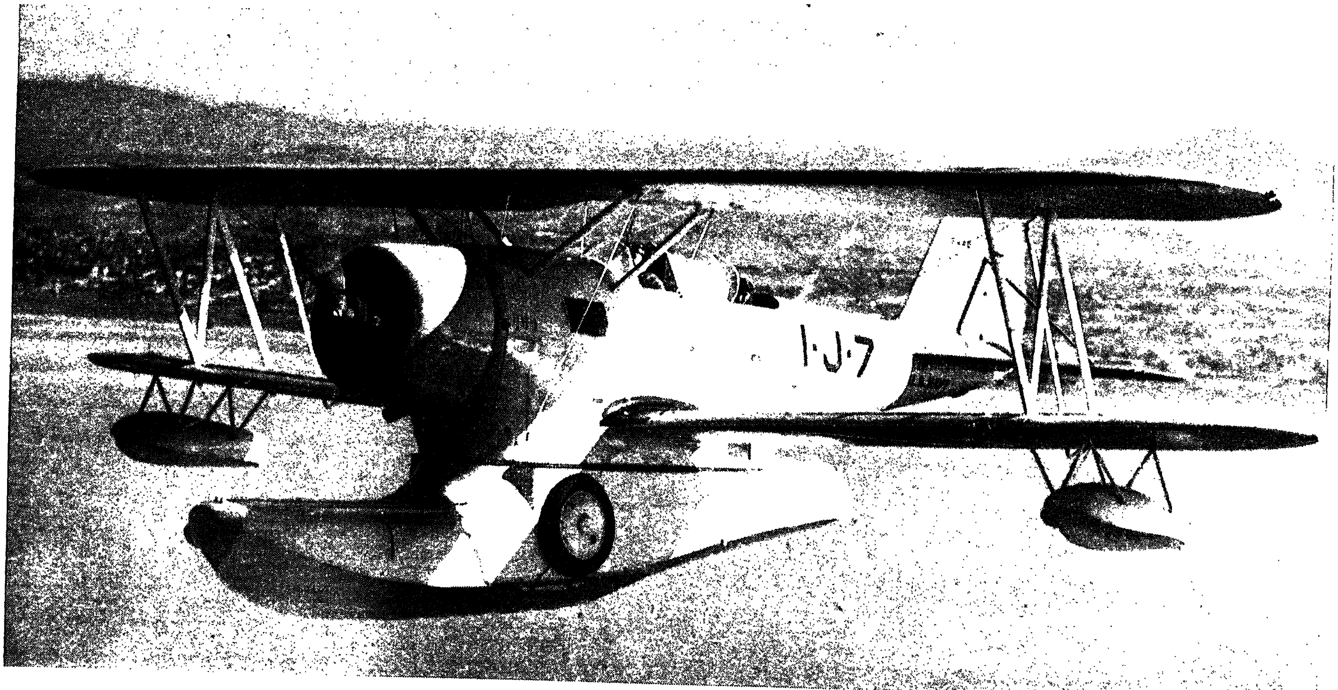
EQUIPMENT

BASE EQUIPMENT

The equipment to be kept on hand at a base naturally depends on what kind of a base it is—whether private, or owned by a small operating company, or run by a municipality for any type of ship. There are few airplanes of the flying boat type today without some sort of beaching or amphibian gear; so they may be practically left out of consideration. However, if it is likely that such may be handled, a cradle shaped to fit the bottom and mounted on wheels will have to be built for the particular ship.

There are a number of devices for handling twin-float seaplanes. The simplest of these is the skid board, which is nothing but a piece of 1″ x 6″ lumber, preferably of hardwood, long enough to reach from the main step to the bow of the float. The serviceability of these may be improved by the use of two guide strips running longitudinally in the middle. These guide strips should be approximately ½″ x 1″ and should be fastened about ½″ on each side of the center of the skid board, thus bringing them far enough apart for the keel to fit loosely between them. Be sure that the strips are lower or thinner than the keel; otherwise they will bear against and possibly injure the bottom. To use the skid boards, pull down the tail of the ship until the stern of the float touches the ramp or floor of the hangar. Push the boards under the keels as far as possible, with the keel of each float between the two guide strips on the board. Lower the nose of the ship, spring the front end of the board up along the keel, and tie it to the mooring cleat on the bow. The ship may then be dragged around with a tractor. The tow line should be fastened in the form of a bridle to the front spreader bar close to the float.

Most floats are equipped with a tube, passing through them near the balance point. This tube is provided for the attachment



Courtesy Grumman Aircraft Engineering Corp.

FIGURE 11. GRUMMAN SINGLE-FLOAT AMPHIBIAN

Note wheels retracted into side of float.

of wheels. Two systems are in use. One employs a short axle, with a wheel or each side of each float (four wheels in all), the wheels being of a diameter sufficient to hold the keel an inch or two clear of the ground or ramp. The best wheels for this purpose are those with a flat rim and a hard rubber tire, unless the ship has to be moved over a very rough surface, in which case pneumatic tires might be more desirable. With this type of beaching gear, four wheels should always be used; thus an undue amount of twist will not be thrown into the floats and bracing. (See Figure 26.)

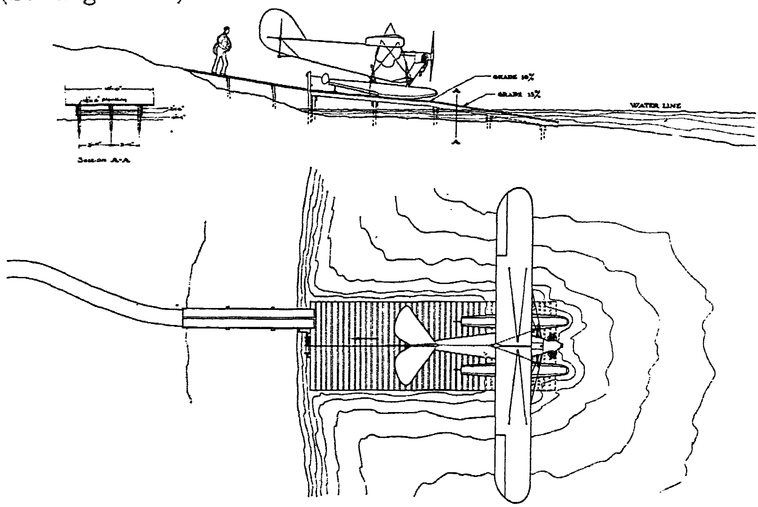


FIGURE 12. SMALL PRIVATE RAMP

There is another type of gear, however, which needs only two wheels, provided the axle is strong enough. A sketch of the device is shown in Figure 27. The construction is as follows: the axle is a piece of steel tubing of the proper diameter and wall thickness to provide the necessary stiffness. The inside diameter should be approximately the same as the inside diameter of the axle tubes in the floats, and a wall thickness of at least 3/16″ is recommended for ships of average size. Wheels are permanently fitted on bearings near the ends and collars at the extreme ends of this axle, the length of which should be such that the collars bear against the inside of the float axle tubes. Inside of the axle are bars which may be slid into the axle tubes by means of

handles working through slots in the axle. The ship is raised by means of blocks (as described below), the axle and wheels rolled into place between the floats, the bars pushed into the axle tubes, and the blocking removed. With one man at the tail to balance the ship, it may be dragged any reasonable distance by tractor, car, or man power.

The following method of raising the ship on blocks may be used whenever it is desired to work on the bottom of the floats,

FIGURE 13. PRIVATE RAMP FOR SMALL SEAPLANES

Note winch for hauling ship up backwards.

to install beaching gear, or to get the floats clear of the floor for any other reason. A number of short planks, six or eight inches wide, about a foot long, and approximately an inch thick should be obtained and arranged in four stacks of equal height between the floats. Two stacks should be near the steps and the other two near the bulkhead just forward of the step. One or more mechanics (depending on the size of the ship) should be at the tail and one between the floats just forward of the step. The tail is pulled down and a block placed under each keel at the bulkhead. Then the tail is lifted until the bows of the floats touch the floor, and a block is placed under the skeg of each float. The tail is again pulled down and another block put under each keel at the bulkhead. This operation is continued until the desired height has been reached. The procedure may appear clumsy and trou-

blesome, but a ship of average size can be raised six inches in three or four minutes, which is probably less time than would be consumed by any other method.

A low four-wheeled truck or dolly causes less abuse, perhaps, than any other type of beaching gear. This may be made with a little ingenuity from old automobile axles and wheels. The front wheels should be provided with a steering mechanism,

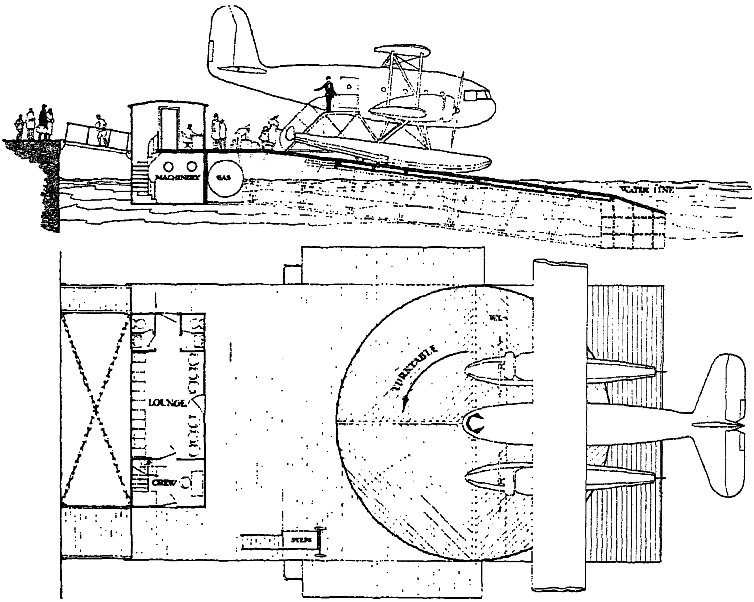


FIGURE 14. TURNTABLE RAMP

usually made from the same auto which provided the axle. On a concrete ramp this can be rolled clear under the water, as illustrated in Chapter II, Figure 17 (the "Boston" dolly). On wood ramps, the ship can be put on after it has been skidded out of the water, by blocking it up to the proper height as previously described. After the blocking up has been done, the ship is rocked back on the stern of the floats and the front blocks removed. The dolly or carriage is then rolled under the floats, the bow lowered onto the dolly and tied down. The ship is removed by reversing the procedure and is left with the blocks under the step, thus freeing the dolly for other ships and leaving the first one so that it can be quickly replaced on the carriage.

It is usually better to leave the ship resting with its nose down and a box or trestle under the rear portion of the float to eliminate the possibility of its tipping back.

The Edo Aircraft Corporation has developed a three-wheeled beaching gear to fit any standard floats provided with axle holes. This is illustrated in Figure 29, which shows it in use on a

FIGURE 15. MARTIN BOMBER ON TURNTABLE

Midtown Skyport, 31st Street and East River, New York City.

Beechcraft seaplane. This device has two studs or spurs attached near the rear wheels to engage the axle holes. The tread of the rear wheels is adjusted by a right- and left-hand thread in the center of the rear axle. The threaded portion is operated from the front through a shaft and bevel gears. The wheels are spread until the studs are forced tightly into the axle holes, and then the studs are raised by turning other shafts running from the front. To keep the ship from rocking on the studs, the propeller hub is strapped to a bar connected to the front of the carriage.

Besides some means for handling ships, every base of any size should be equipped with a tractor for hauling them around. Another necessity is a small motorboat (or at least a rowboat),

DOWNTOWN SKYP(WALL   YORK

for occasionally a ship needs assistance, especially under such conditions as motor failure, drifting away when improperly tied, unloading passengers when the ramp is blocked, and other emergencies. An ample supply of ropes of various sizes should always be on hand, neatly coiled. A boat hook with a long handle is often a great help. For wetting the ramp (if of wood) and for washing down ships around salt water a hose is almost essential. Life preservers of the round or doughnut type attached to a light line should be kept in easy reach. Fire-extinguishing equipment, especially of the foam type, is a self-evident requirement. A complete supply of tools for emergency repairs should be available, whether licensed mechanics are on hand or not, and an assortment of bolts, nuts, rivets, safety wire, friction tape, dope, and fabric will often be of great help.

Flying Equipment

The Department of Commerce requires that "aircraft flying over large bodies of water must be provided with an adequate supply of food and potable water, a compass, a Very's pistol (or approved equivalent), and life preservers or other flotation devises approved by the Secretary of Commerce." There are other items of equipment which will save a seaplane pilot much inconvenience and often prevent damage to the ship. The first of these is a reliable self-starter. When maneuvering in restricted quarters, this is an absolute essential if one wishes to avoid damaged wing tips and tail surfaces. The next is an anchor which should be stowed *where it can be taken out in a hurry.* The anchor line should be neatly coiled, so that there is no danger of its snarling when the anchor is dropped. The length of the line, of course, depends on how deep the water is, but in any case the longer the line the better—the minimum desirable length is five or six times the depth of the water. The strength of the line should be about 75% of the gross weight of the ship. The weight of the anchor needed depends on the weight of the ship. Roughly speaking, for normal weather and the conventional types of anchors, there should be about one pound of anchor weight for each two hundred pounds of airplane weight. In other words, a ship weighing around 3,000 lbs. should carry a 15 lb. anchor. Two types of anchor have proven themselves well-adapted to seaplane uses. These are the Eells and the Northill.

The latter is made of stainless steel sheet formed into shape and, hence, is very light. Tests indicate that it has several times as much holding power as other anchors of the same weight. It is especially sensitive to the angle of the line, however, and the length of the line should always be at least six times the depth of the water and preferably more.

In addition to the anchor line, a small heaving line about ¼″ in diameter and fifty feet long should be carried; and it is also worth while to have another line of the same length but somewhat heavier for tying down over night or for mooring. In addition, several short pieces, eight to ten feet long, will be useful for tying up to floats or docks. To protect the ship when so tied, small cork fenders, two or three inches in diameter and a foot long, should be provided. Small lead sinkers at the lower end of these will keep them from floating on the surface. A mooring bridle may often save time and annoyance. This is made of line about the same size as that used on the anchor, and may consist of two pieces spliced into a ring or one piece served around a grommet at the center. If the two-piece construction is used, the length of each piece when finished should be about 75% of the tread of the floats. Each piece should have an eye splice (without a thimble) at one end, the size of the eye being such that it will just go over the mooring cleat on the bow of the float. The other end should be spliced around a thimble fitted into a ring on which is mounted a large, strong snap hook. The one-piece bridle is simply a single piece with eye splices at each end and wrapped and served around a grommet at the center. The grommet may be fitted to a snap hook if desired. The length of the one-piece type between eyes is, of course, one and one-half times the tread of the floats.

A canoe paddle with a boat hook fitted to the handle end will often be found of great help in picking up moorings, in paddling away from a dock when there is no wind, or in case of motor failure. It is admittedly slow work and little fun to paddle a seaplane with a dead engine for several miles, but it can be and has been done; and heartbreaking though the job may seem, it is far better than drifting out to sea. A bilge pump is very necessary on long trips, especially if the floats or hull are not absolutely tight. A small fog horn may prove serviceable, also a cardboard megaphone. A sea anchor made of a piece of can-

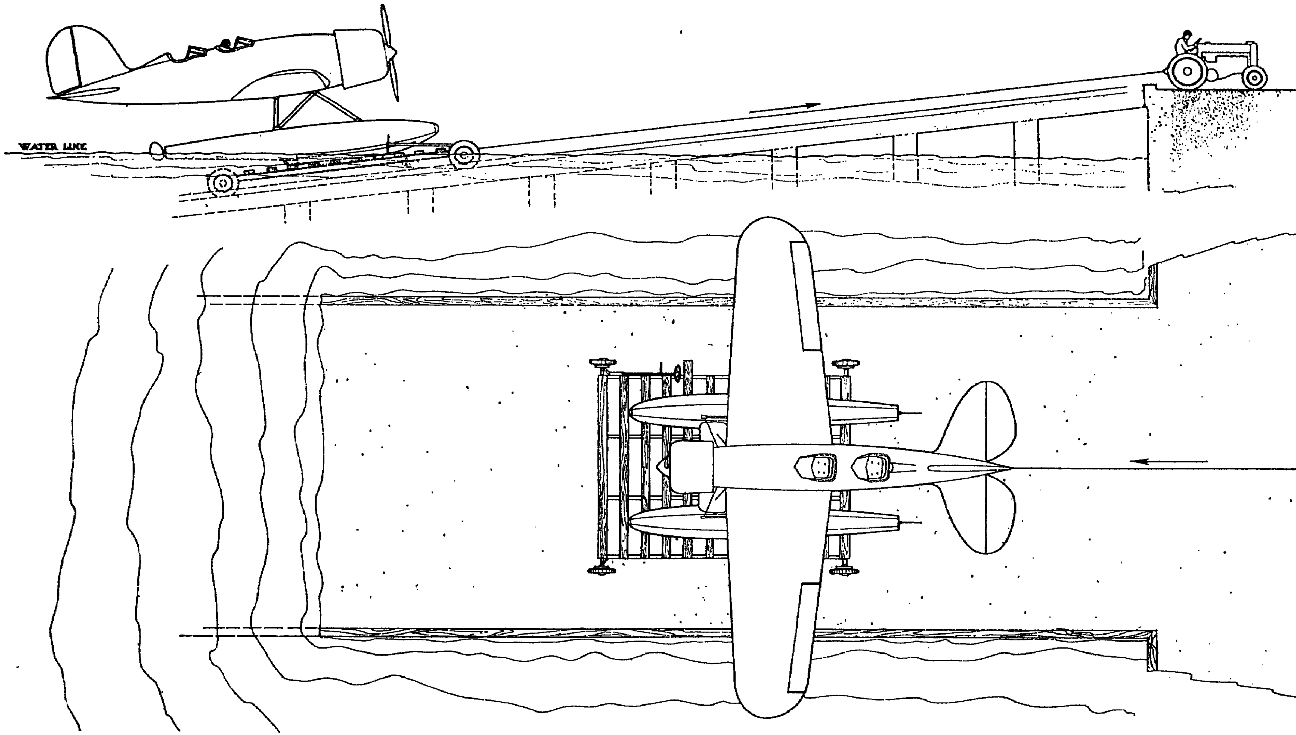


FIGURE 17. "BOSTON" RAMP AND DOLLY

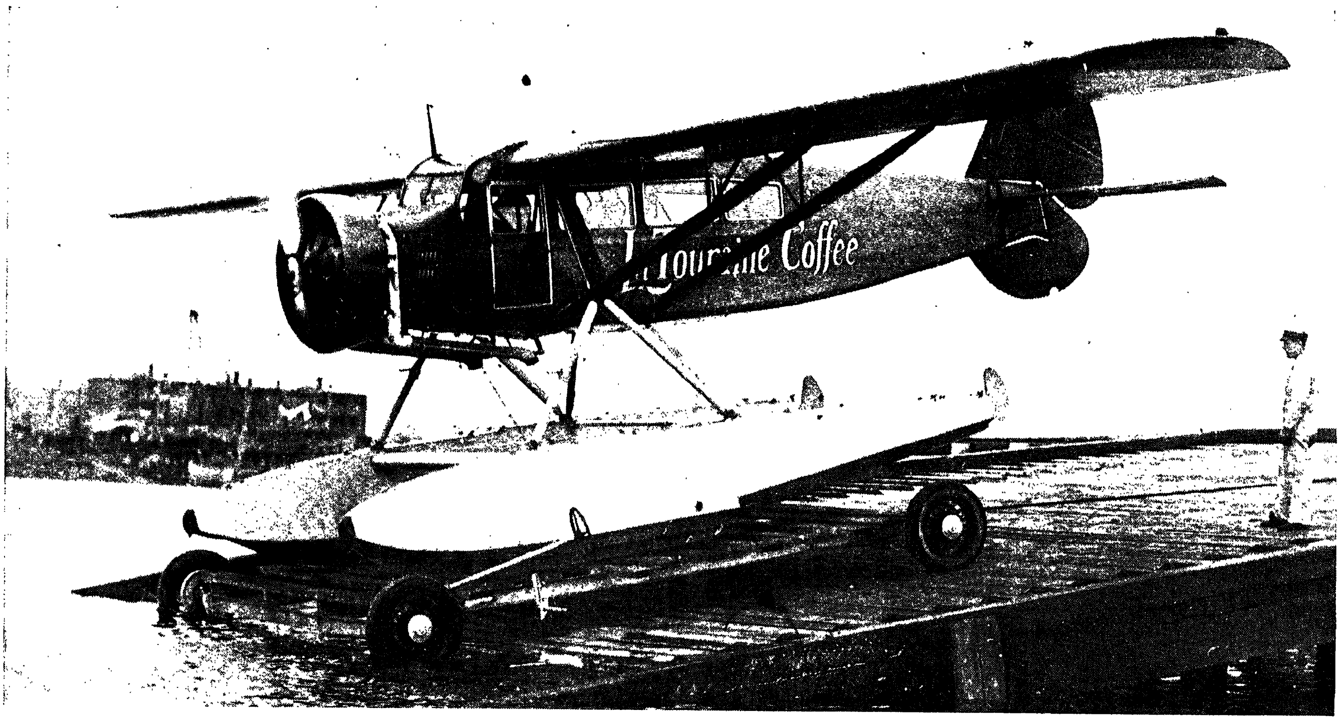


FIGURE 18. "BOSTON" TYPE DOLLY IN USE—LAUNCHING

vas about three feet square, with two sticks to fasten to opposite corners and hold it extended, is a good thing to have in case of forced landings at sea. If fastened to a bridle attached to the floats and given about twenty or thirty feet of line, it will hold the nose of the ship into the wind. A motor or cockpit cover (if one is carried) makes an excellent sea anchor when extended with crossed sticks of wood.

Enough tools to make minor repairs should, of course, be on board; and on long trips a small jar of dope and some fabric should also be included. A leak may be temporarily repaired with fabric doped on. Safety wire and friction tape will often be valuable; and if flying in cold weather, an electric oil heater is well worth while in order to save time in warming up.

A flashlight with new batteries should by all means be quickly available. If night work is contemplated, a taxying light, consisting of a powerful auto or motor boat spotlight should be attached somewhere under the fuselage. The regulation landing lights are not satisfactory on seaplanes, either for landing or taxying. The same is true of small flares. Water lights, which may be thrown overboard and which light as soon as they strike the water, are valuable for forced landings at night. They give very little light but enable the pilot not only to tell just where the water is, but also the direction of the wind.

Since practically all seaplanes are now equipped with water rudders, it seems almost superfluous to mention them. However, in case anyone contemplates buying a set of floats without them, let him at once change his mind, as a seaplane without water rudders is mean for the expert to handle, and for a beginner it is next to impossible. The rudders should hang down below the float or hull, so that they will be working in relatively undisturbed water. They should be so arranged that they will swing up if they strike any solid object. Also, they should be equipped with lifts, so that the pilot may pull them up when taking off; otherwise they will be subjected to much unnecessary abuse.

All these items may appear to be superfluous accessories, but the total weight—exclusive of the anchor—is probably not more than twenty pounds; and it is safe to assume that any pilot who has put in a few hundred hours of miscellaneous seaplane flying has more than once either been thankful that he had them or greatly regretted that he did not.

Chapter IV

ENGINEERING CONSIDERATIONS

Many prospective seaplane pilots have a rather hazy idea of what is involved when a landplane is converted into a seaplane. A detailed technical discussion from an engineering standpoint is not within the scope of this work, but there are a few simple and fundamental facts with which the seaplane operator should be familiar. A knowledge of those outlined below may prevent disappointment and will surely lead to a better understanding of seaplane engineering problems.

Effect of Conversion

A certain decrease in performance is to be expected in any airplane when both its weight and its resistance are increased. How much this decrease amounts to depends on the design of the landplane. On one-type of small light ship, for instance, it was found that there was no loss whatever in top speed when the change was made from wheels to floats. On the other hand, when another ship, with retractable landing gear, was converted into a seaplane, the drop in top speed was about 25 m.p.h. In general, in the case of a landplane with a maximum speed in the neighborhood of 150 m.p.h., a decrease of 8 to 10 m.p.h. may be expected as a result of the conversion. This decrease is less marked, of course, at cruising speed. In many cases, the slight loss is far more than offset by the ability of the seaplane to land the passenger much nearer his ultimate destination. For example in the run from New York City to Philadelphia, or from New York to Albany, a seaplane with a cruising speed of 150 m.p.h. will be quicker from the passenger's point of view than a landplane which cruises at 200 m.p.h., due to the time lost in traveling to and from the airport. This time, in the cases mentioned, amounts to considerably more than the flying time involved. Since the seaplane can take off from either of the rivers

in the heart of New York City and land in the business district of the other cities, the saving is obvious. And since most of the important cities are built on the water front, the example given is not an isolated case.

As regards take-off and climb, the seaplane is also somewhat behind the landplane. But here again there is no occasion for concern, for there is usually, except in very small lakes, ample

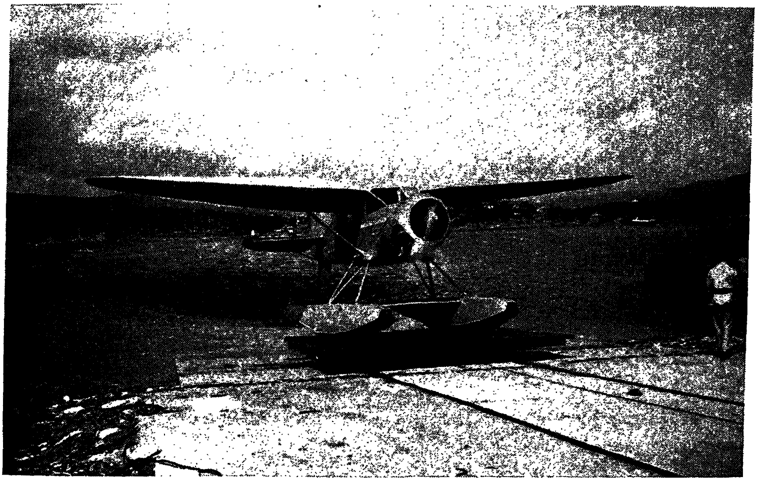


FIGURE 19. ONE TYPE OF MARINE RAILWAY IN USE IN NORWAY

room and there are no obstructions to clear. Ordinarily the element of danger from motor failure on the take-off (which is ever-present in the landplane), gives the seaplane pilot no worry, as in most cases he can land immediately after taking off and without having to turn.

The difference between landplane and seaplane as to maneuverability in the air, stability, and general handling qualities is so slight as to be unnoticeable. Figure 30 illustrates a maneuver which is just as easy at it was before the wheels were replaced by floats. Forced landings with a seaplane when flying over water are usually only an inconvenience instead of a catastrophe; forced landings on land present no greater problems than in the case of a landplane. (See Figure 55.) In fact, in swampy ground or high grass, the seaplane is much less likely to nose over than the landplane.

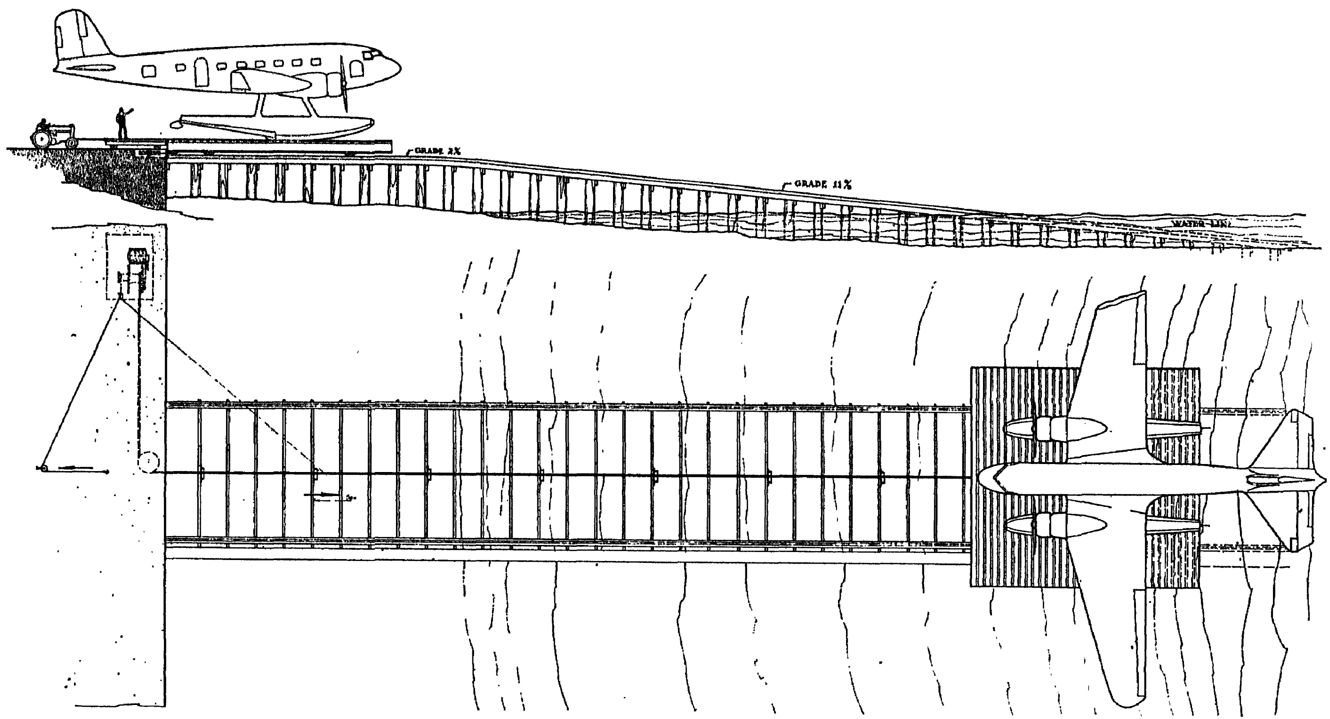


FIGURE 20. MARINE RAILWAY

Propellers

As already pointed out, a seaplane is usually not quite so fast as the same ship on wheels. Furthermore, a great deal more power is needed for take-off, the maximum generally being required just before the ship goes on the step. (See Chapter VI.) These two characteristics necessitate a change in the design of the propeller, and if the landplane propeller is not changed, the sea-

Figure 21. Marine Railway, Colombia, South America

plane performance is almost certain to be disappearing. This is assuming, of course, that the propeller used with the ship on wheels is the most efficient for that condition.

The change in design involves a decrease in the pitch, so that the engine will produce its full r.p.m. in spite of the lower speed. For good take-off characteristics, it is often desirable to increase the diameter of the propeller. The shape of the blade may likewise enter into the problem. These changes call for a certain amount of experiment, in which case the wood propeller (being by far the cheapest type) is the best to play with. The importance of correct design of the propeller cannot be overemphasized, for many times a ship which will refuse to get into the air at all under bad air and water conditions, can be made to show fair or even good performance simply by changing propellers.

There are five main types of propellers: the *controllable pitch* type, in which the pitch can be regulated from the pilot's cockpit while in flight, used only on engines properly designed therefor; the *automatic variable* pitch, which is not controlled by the pilot, but which automatically decreases the pitch during take-off and increases it as more and more speed is attained; the *adjustable* pitch, in which the pitch can be changed in the

FIGURE 22. "SKY HARBOR"
A floating hangar built on a barge.

shop but not while the propeller is mounted; the *one-piece forged duralumin* type, which can be repitched within small limits at a regular propeller service station; and the *wood* propeller.

Of these five, the first two will probably produce the best all-around performance. Following in order of performance comes the one-piece forged type, which also is likely to provide the best cooling for a radial engine; and next, but only slightly behind the forged dural in performance, is the wood prop. And since the price of the wood type is only about one-fourth that of the

forged dural and one-tenth the price of the variable or controllable styles, it is attractive to many operators. In general, if properly made, the wood propeller will stand up about as well as the metal types, and in some respects possibly better. Many manufacturers will guarantee satisfactory performance, and, as mentioned before, the price is reasonable enough to permit trying

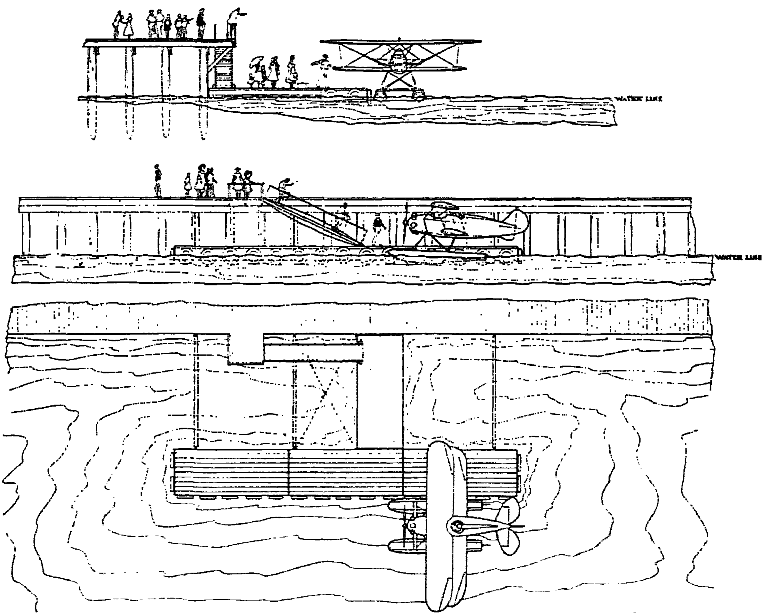


FIGURE 23. RAFT CONSTRUCTION

more than one if it seems desirable. When ordering, however, it should be specified that the propeller is to be used on a seaplane; and, of course, the horsepower, maximum speed, and any other available performance data should also be given.

DISPLACEMENT AND PLANING SURFACE

As a rule, the purchaser of floats or flying boats has little opportunity to have anything to say about the design, inasmuch as the product is already built when he buys it. This is perhaps fortunate, as the manufacturer is usually much better qualified to decide on any problems which may arise and is naturally eager to turn out the best job possible, consistent with price and other

considerations. However, it is desirable for the seaplane operator to have some idea of the effect of varying displacements and types of bottoms.

Any floating object displaces a volume of water equal in weight to the weight of the object. Or, in other words, the weight of the water displaced equals the weight of the floating object. *Displacement,* then, is usually expressed in terms of weight. If a seaplane or boat is floating in perfectly calm water, and a line is drawn clear around the float exactly at the surface of the water, this line

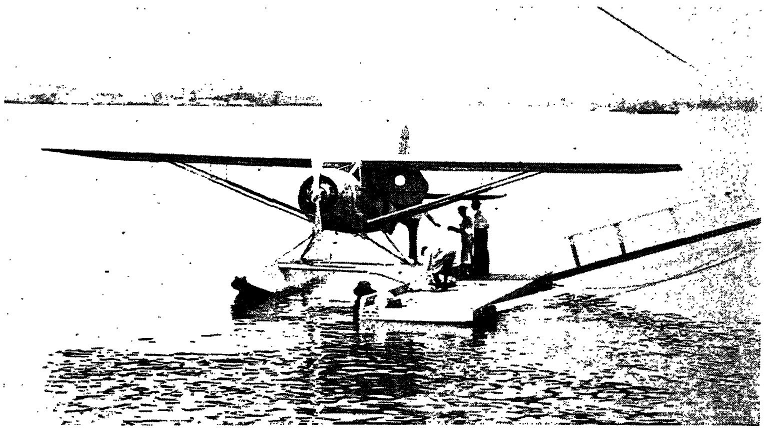


FIGURE 24. LOADING BELLANCA SEAPLANE FROM RAFT

is called the *water line.* If the ship were now set on shore and the floats or hull filled with water up to the line drawn, the weight of the water would equal the weight of the airplane. However, there would still be much space left inside the floats. The weight of the extra water required to fill the floats completely is called the *reserve displacement.* Expressing it differently, assume the ship is afloat and loaded to its normal gross weight. Next, assume that there is put on board just enough extra weight to submerge the floats—or sink the plane. The amount of this extra weight is equivalent to the reserve displacement. Normal displacement, plus reserve displacement, or the total weight required to just submerge the floats is called the *submerged displacement* or *total displacement.*

Sometimes the word *buoyancy* is used instead of *displacement* and *excess buoyancy* for reserve displacement.

The Department of Commerce requires that the reserve displacement be at least 90% of the actual displacement, and, as a rule, the designer allows even more—perhaps 10%. This means that if one float of a twin-float seaplane were completely filled with water, or even knocked off in a collision (though such an occurrence is hardly possible), the ship still would not sink, although unless immediate steps were taken, it would probably turn over. The procedure in such cases is discussed in Chapter X under the heading "The Badly Damaged Seaplane."

It is, of course, impossible for manufacturers of commercial floats to build a different size for each airplane and keep the price within bounds; so it is necessary to group airplanes into definite weight classes, each class embracing all ships of the same weight within several hundred pounds leeway, and then build one standard float for all those in the same class. The classes used by the largest manufacturer of floats in this country are given in Appendix A in the back of this volume.

There are many other factors which affect seaplane performance, particularly in respect to take-off. One of the most important of these is the shape of the bottom. Figure 31 illustrates various types of bottoms, the section shown being taken slightly ahead of the main or forward step. The bottom, as is the case with the remainder of the airplane, must be a matter of compromise. Quick take-off must, to some extent, be sacrificed for seaworthiness and "softness" in rough water. Generally speaking, the flatter the bottom, the quicker the take-off in calm water; and naturally under this condition the take-off requires the longest run. On the other hand, in rough water a flat bottom causes severe pounding and abuse of the floats and may actually thereby get off more slowly in a bad chop than a sharp bottom which slices through the waves instead of slapping them. The flat bottom then is suitable only for inland waters which are seldom choppy.

The same is true of the single-concave bottom, which has been used by some European manufacturers on flying boat hulls, but is seldom seen in this country. The double concave is desirable because it combines the advantages of the blunt and the sharp "V" by providing a sharp entry into the water yet a comparatively flat surface on which to plane. It also deflects the spray downward, which the plain "V" does not. However, it is expen-

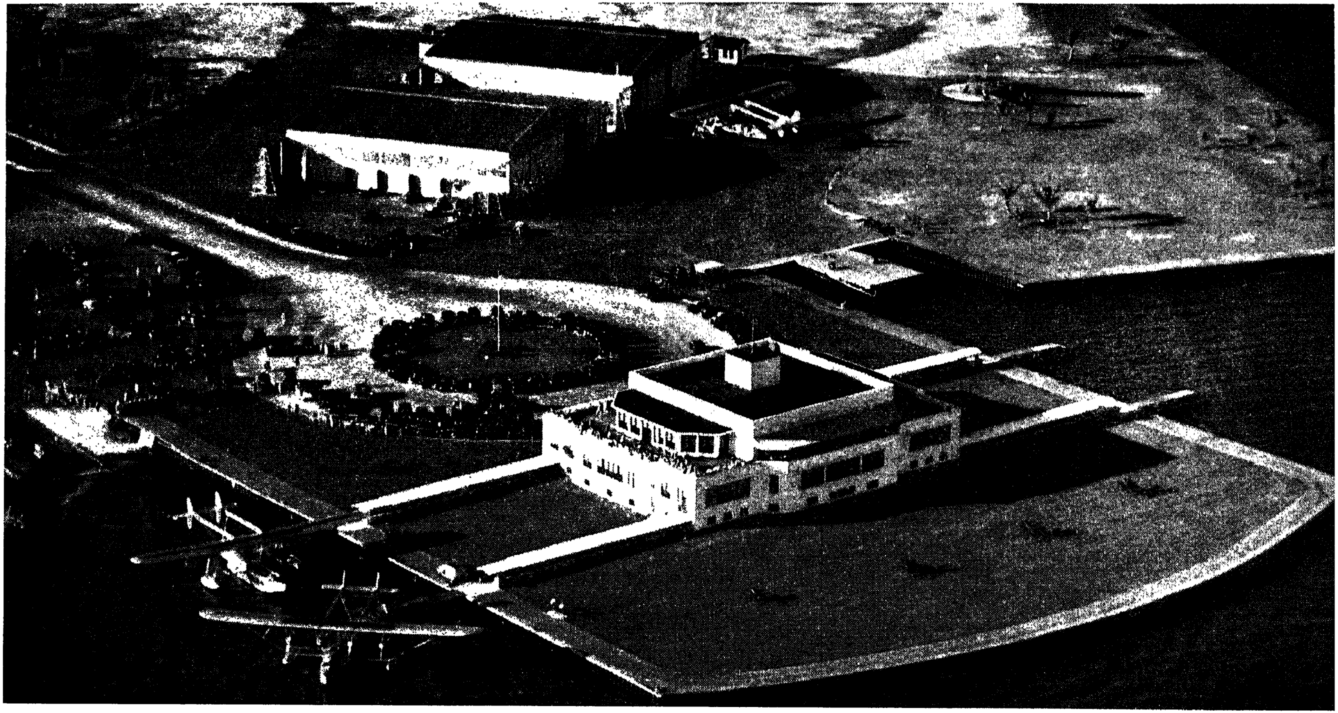


FIGURE 25. A WELL-EQUIPPED SEAPLANE BASE—THE PAN-AMERICAN AT MIAMI, FLORIDA

sive to build. Probably the best all-around combination and compromise is the fairly sharp scalloped bottom. As the ship picks up speed, it is supported successively on lower scallops, and thus there is less and less drag from the water. Also, the spray is thrown down as in the double-concave type. (Note Figure 2.)

In taking off, a seaplane or boat is first supported by its normal buoyancy or displacement. As the throttle is opened the force of the water raises the bow more and more until the rear portion refuses to be submerged further, both because of its buoyancy and because of the force of the water moving by. The increasing speed then forces the stern up and the bow back down, so that the float instead of running *through* the water is *planing* on the surface in a manner similar to the familiar aquaplane. If this planing did not occur, the ship would never develop speed enough to take off, as the engine of a conventional airplane could never produce enough power to overcome the drag and suction caused by the float or hull passing through the water. The step is necessary to allow the float to break away from the water at the rear and rock over into the planing position, which reduces its resistance and, at the same time, allows the pilot a certain amount of longitudinal control for taking off.

Once the ship has begun to plane and is "running on the step," the take-off is only a matter of overcoming the resistance of the air and water until flying speed is attained. It is this fact which gives the advantage to the scalloped bottom which, as the speed increases, allows the ship to plane on successively narrower surfaces, gradually decreasing the area of the bottom in contact with the water and thus decreasing the water resistance and lessening the time and distance required for taking off.

Wing and Power Loading

The weight of the ship, divided by the area of the wings in square feet, gives the number of pounds carried by each square foot of wing surface. This is called the *wing loading* and is an important factor in take-off of either land or water airplanes. It is probably more important in the case of the latter, however, as the lower the wing loading, the slower the take-off speed. And since the water drag increases as the *square of the speed,*

Figure 26. Bellanca Seaplane on Four-Wheeled Beaching Gear

it is obvious that much less power will be required to pull the ship through or on the water at low speed than at high.

The *power loading* is a corresponding figure obtained by dividing the weight by the horsepower. The lower this figure, the more power proportionally there is available for acceleration. Hence, this also plays an important part, for if there is a large amount of extra power, it will offset much more quickly the drag caused by the water and air. The ideal ship for quick take-off would have a low wing loading, a low power loading, and a comparatively flat bottom. Such a design would fairly leap into the air, but the owner would complain because of low speed, high

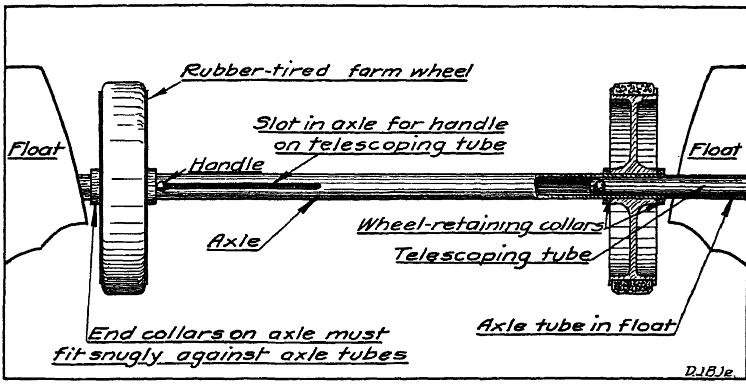


FIGURE 27. TWO-WHEELED BEACHING GEAR

gas consumption, and severe pounding in rough water. The obvious remedy for these faults would be to have higher wing loading and sharply "Vee'd" floats, thus increasing the top speed and fuel economy and improving the rough water qualities. Then the pilot would growl about the take-off. So—what to do?

DEPARTMENT OF COMMERCE APPROVAL

Many buyers or prospective buyers of floats think that all that is necessary to put their landplane on floats is to determine in what weight class their ship is and order the corresponding floats. Unfortunately, however, there is more to this than meets the eye. A seaplane is subjected to an entirely different set of stresses from a landplane. Hence, before the Department will give consent even to install the floats, the whole stress analysis

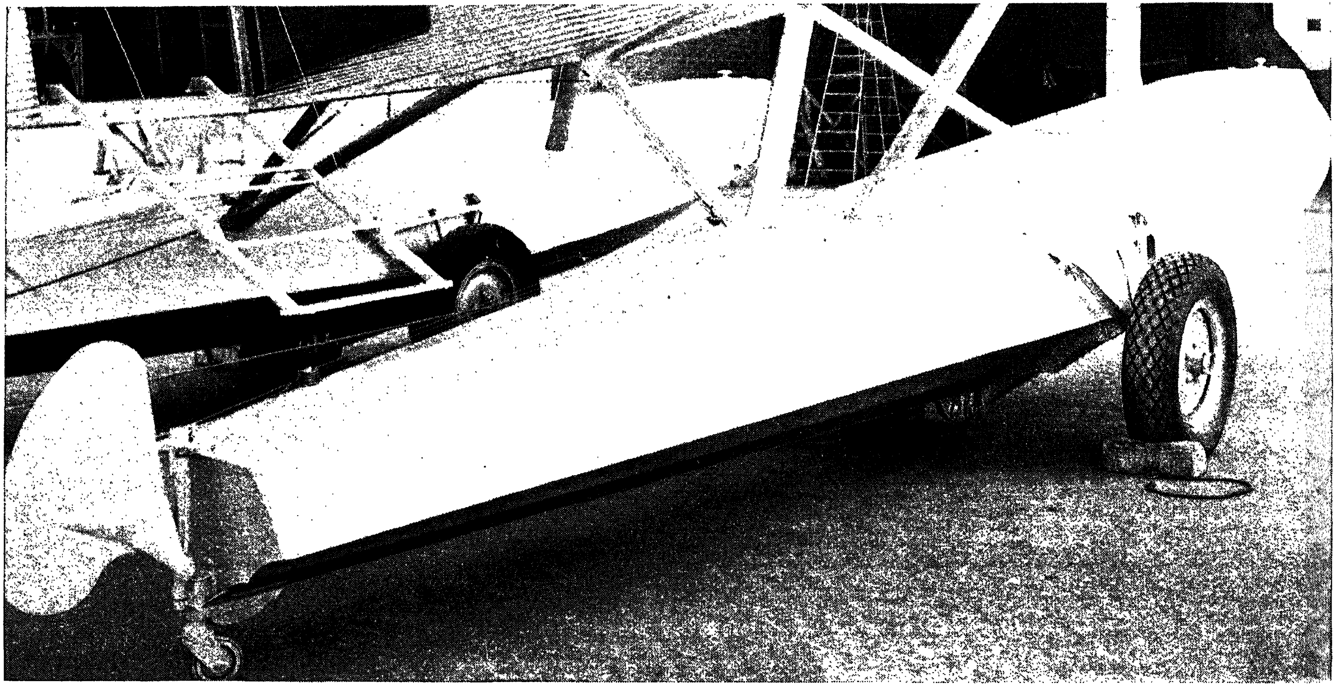


Figure 28. Special Beaching Gear Used on Ford Tri-Motor

Also an excellent view of water rudder and float details.

of the fuselage (and sometimes of the wings as well) must be gone through and refigured to take care of seaplane conditions. This may require several weeks at the airplane factory and some more time at the float factory. Then the Department has to check and approve these figures, and this generally requires several additional weeks. And in the course of the calculations it may be found that some members which were amply strong for the land plane will have to be reinforced or replaced for the seaplane. When the float manufacturer states in regard to a certain ship, "Engineering approval is guaranteed," it means that all of this work has been done.

But even this is not the whole story. The installation of floats sometimes affects the flight characteristics, especially if the ship is somewhat shy on directional stability. In this case, the added side area or lateral fin area of the floats projecting out in front of the center of gravity may cause the ship to become actually unstable directionally—or, in other words, it won't remain on a course without constant use of the rudder, and if swung off by a bump, it tends to swing further instead of coming back. This may also lead to bad spin characteristics. Both conditions can usually be corrected by the simple addition of a small fin at the tail of the ship—usually installed below the fuselage. All this must be taken care of before the ship can be licensed.

It should be clearly understood, however, that in any licensed seaplane, each of these factors has been thoroughly studied and any deficiencies overcome, that the ship has been test-flown, spun, and carried through the customary Department of Commerce requirements. Hence, the purchaser may rest assured that before he receives his seaplane, it has been thoroughly proven to be as strong, as stable, and as airworthy in every respect as the equivalent landplane. The details are mentioned for the benefit of those impatient souls who want to order floats (for a type of ship which has never been put on them before) on one day, and strike out on the water the next.

Chapter V

PREPARATION, INSTALLATION, CHECKING

Preparation of Landplane for Seaplane Use

Careful reading of this section may save the seaplane owner many dollars. Properly prepared and protected, a ship will last as long when used as a seaplane as when it is kept entirely away from the water. Unprotected, it will go to pieces rapidly, and the owner is likely after one season to find himself with a sizable repair job on his hands.

As a matter of fact, any landplane kept on an airport adjacent to salt water will show a slow but sure deterioration due to the effect of the salt air, though corrosion is naturally much more rapid when the ship is used on floats, assuming, of course, that no precautions have been taken against it. Some manufacturers, if notified in advance, will incorporate the necessary corrosion-proofing and relieve the buyer of any further trouble on that score. In the case of flying boats, there should likewise be no occasion for concern, as the manufacturer has presumably done everything necessary to insure the durability of his product. Hence, the suggestions below apply particularly to landplanes which are to be converted to seaplanes.

The ideal time to take care of the situation is while the ship is being built. This is possible only when the original buyer knows that the ship is to be put on floats. The next best opportunity, which is almost as good as the first, is at the time the airplane is undergoing a major overhaul and has had the covering completely stripped off. However, if circumstances are such that the work cannot be done conveniently under either of these conditions, it is still entirely possible to do a thorough job, *provided* that conscientious attention be given to the matter and that no detail of the work (or of the airplane) be neglected. The procedure when the ship is uncovered differs somewhat from that

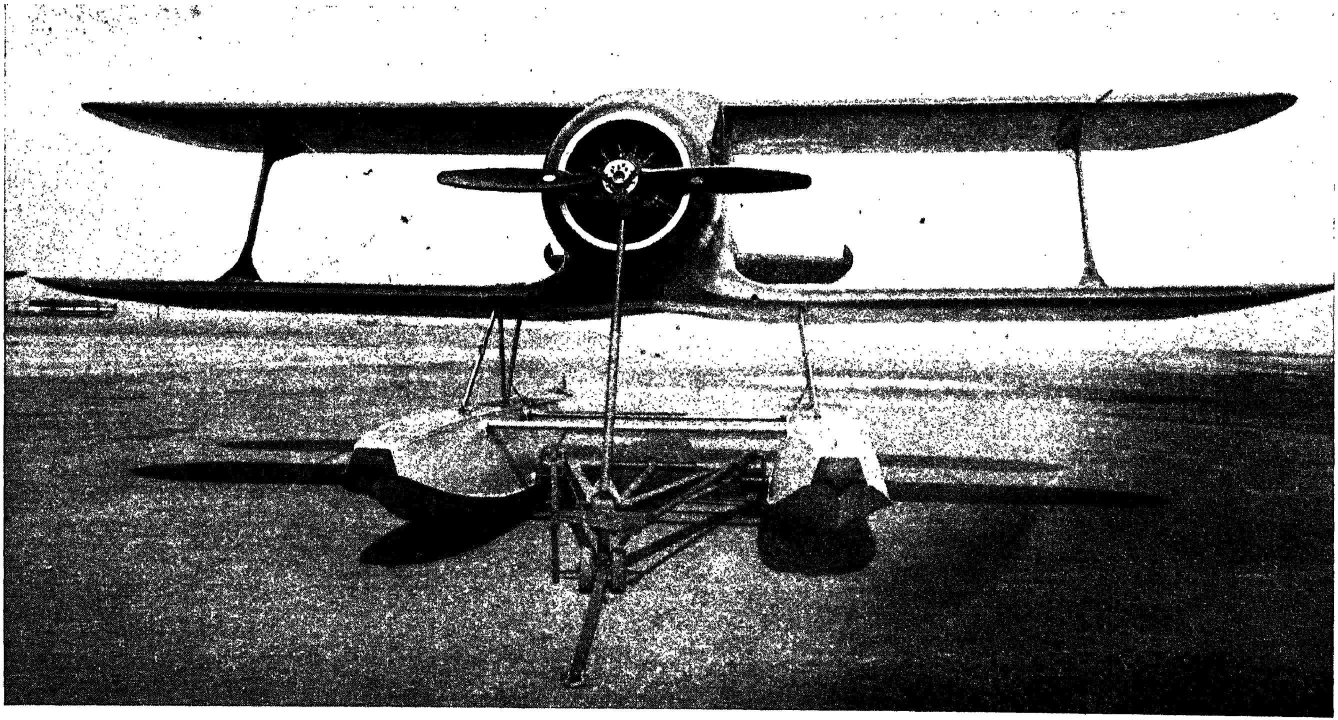


FIGURE 29. "EDO" UNIVERSAL THREE-WHEELED BEACHING GEAR

necessary when the cover is on; so the two cases will be considered separately.

If the covering is off, all steel tubes which have their ends sealed should be filled with oil and drained, unless this item has already been taken care of by the manufacturer. The method consists of drilling holes about 1/8″ in diameter near each end of the tube, filling it with hot linseed oil or Lionoil by means of a pump, and allowing it to drain. The holes are then plugged with Parker-Kalon drive screws. If the job has been done by the manufacturer, it will probably be indicated by the presence of these plugs.

Experience to date indicates that one of the best means of protecting the outside of steel tubing (or other large steel parts) is a process known as metallizing. This consists of spraying the steel with a molten corrosion-resistant metal, such as cadmium or chemically pure aluminum, the latter having proven the best for parts subjected to heat, as in the case of exhaust manifolds and cylinder barrels. The Metallizing Corporation of America, 44 Whitehall Street, New York City, has in the larger cities agents who are in a position to do this work, and the cost is usually a good investment on the part of the seaplane owner. If the metallizing service is not available, steel tube structures, such as fuselages and tail surfaces, should be thoroughly cleaned and primed, preferably with oil base red oxide primer, care being taken that the primer runs into all corners and crevices. After the primer has dried thoroughly (usually 24 hours), two coats of good aluminum enamel such as Valspar should be applied. The Edo Aircraft Corporation uses as interior finish on floats an enamel made of Bakelite varnish by mixing one pound of extra fine aluminum powder into one quart of "paint and varnish makers'" naphtha; after stirring thoroughly, the mixture is added to one gallon of the varnish. This may be thinned further for spraying, or may be brushed on. After the two coats have dried, all surfaces in contact with fabric should be further protected with aluminum foil. This material comes in rolls of convenient widths and may be obtained from the Aluminum Company of America, or from accessory dealers. It is applied by varnishing the surface to be protected and allowing the varnish to become tacky. The foil is then laid on the surface and smoothed down with the fingers. If the painting and application of the foil are

conscientiously done, the structure is protected almost (if not quite) as well as by metallizing, and should give no trouble for several years.

If possible, all small fittings should be cadmium-plated. In any case, they should be painted as described above, and if located so that they are not likely to come in contact with one's clothes, should be covered with grease before installation. There are a number of greases designed particularly for such purposes. Among them are "Rust-Veto" A-7, manufactured by E. F.

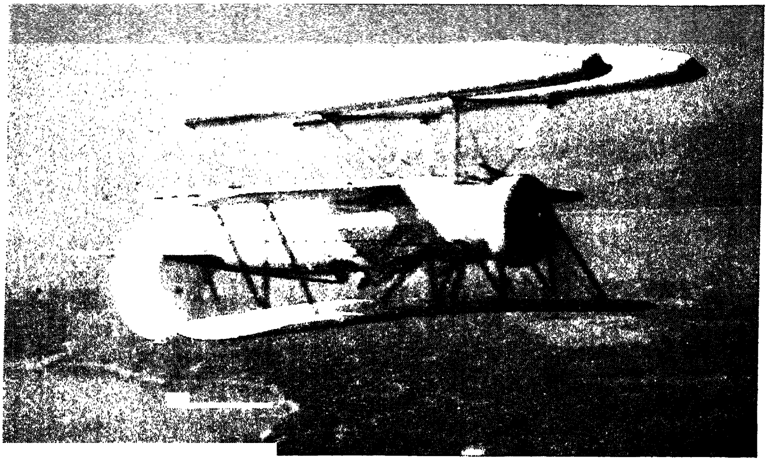


FIGURE 30. A WACO SEAPLANE IN A SLOW ROLL

Houghton and Company, "No-Ox-Id G," by the Dearborn Chemical Company, and "Corol" No. 135, by the Simonize Company. One of the most satisfactory preparations is a 50-50 mixture of beeswax and white petrolatum melted together. The compound seems to be somewhat improved if boiled several times and allowed to cool after each boiling. All heavy greases of this nature should be applied hot enough to be liquid. Their appearance, when used on external fittings, may be improved by stirring in aluminum powder while they are melted. After the parts to be protected have been thoroughly coated, the flame of a blow torch may be passed lightly over them. This causes the surface of the grease to melt and run smooth.

The threads of all tie-rods and turnbuckles should be dipped in melted grease before assembly, and the whole end thoroughly

coated after adjustment. All control cables, unless made of stainless steel, should be rolled up and immersed in boiling grease.

Wood parts should be given at least two heavy coats of varnish, and where they come in contact with fabric should be further protected by aluminum foil or dope-proof paint. Wood

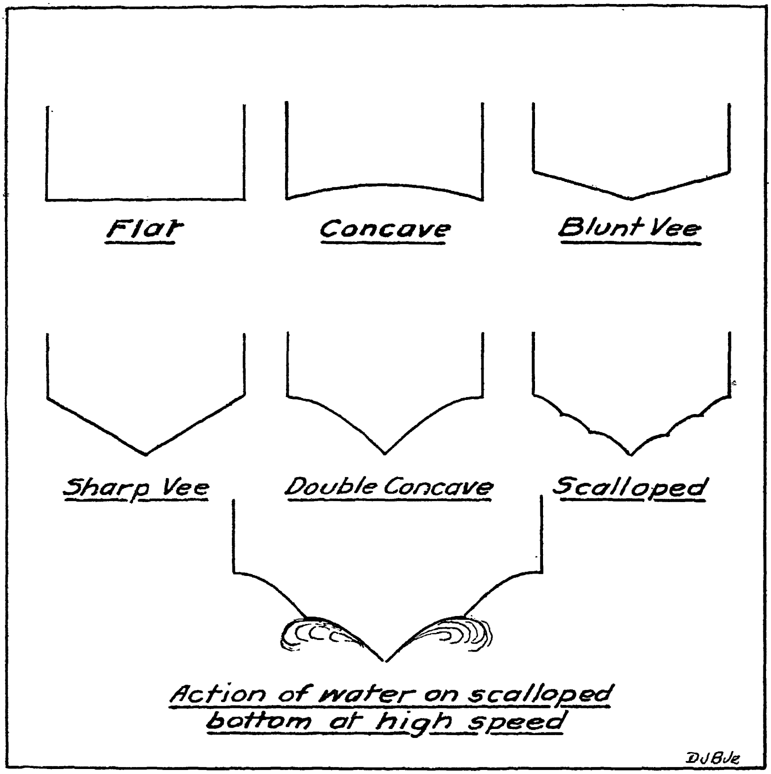


FIGURE 31. VARIOUS TYPES OF BOTTOMS

parts which bear on metal will hold moisture against it and cause corrosion unless both the wood and the metal are thoroughly painted.

The foregoing instructions constitute what might be called complete specifications, and as many as possible should be carried out. However, as stated before, a good job can be done even if the ship is covered. In such a case, the fuselage, wings, tail

surfaces, and all covered parts should be "fogged" with melted Corol or Rust-Veto. The grease is heated until it is as thin as possible. It is then sprayed from a regular paint spray gun set to a fine adjustment. All inspection holes and doors should be kept open to afford maximum circulation of air and the gun is kept moving to avoid building up the grease at any point. If there are not enough doors to enable all parts to be reached, additional holes should be cut and patched later. It is not necessary, however, for the spray to strike directly on the surfaces needing protection if there is sufficient circulation, as the fog will permeate the whole structure and settle in the form of a fine film of grease.

After the spraying has been done, all openings in the cover which are not absolutely essential should be closed with patches or plates and made as watertight as possible. The openings referred to are those for tail wheels, landing gear struts, and the like. Also, it will often be found that slots for stabilizer struts, controls, and so forth, may be closed partially or entirely with a boot or shield of some sort.

Special care should be given to the inside of dural parts such as control surfaces and fairings. These may be fogged, or in some cases filled with Bakelite varnish or Lionoil and drained.

All tubes with open ends, such as interplane struts, should, if possible, be filled with hot grease and drained, or fogged if filling is not practicable. If the ends can then be plugged, so much the better.

Covered surfaces should have ventilation and drainage grommets of the scoop type installed at the points which are lowest in both the flight and at rest positions. Care should be taken to see that these are opened after installation, for although they are obviously worthless otherwise, the point is often neglected.

It is desirable to cover zippers with friction tape, especially where the ends meet, if they are so located that spray is likely to strike them, as on the bottom of wings, or fuselage, or near the tail.

Exhaust manifolds must be metallized, otherwise their life will be short. Cylinder barrels and other steel parts of the engine may receive the same treatment. Some manufacturers of engines have hesitated to recommend this procedure on the ground that the cooling might be impaired. A number of tests,

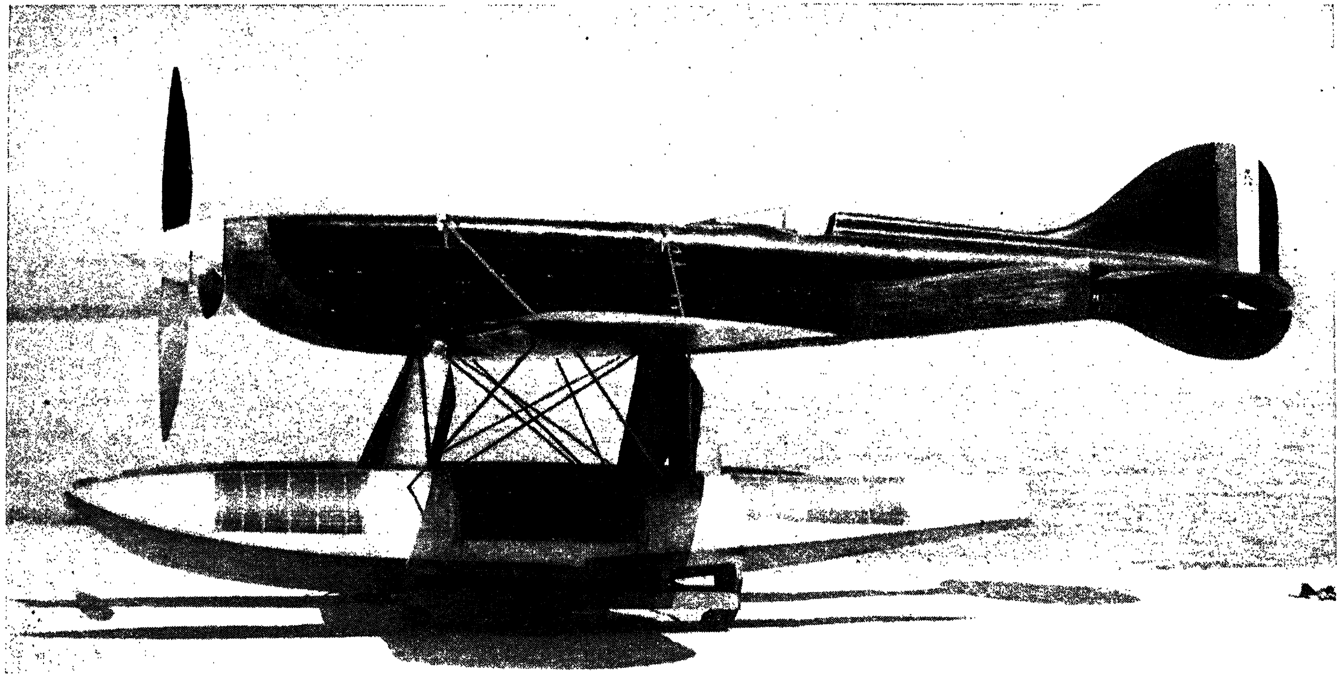


FIGURE 32. THE MACCHI-CASTOLDI (ITALIAN) TWIN-FLOAT SEAPLANE

The world's fastest airplane—440 miles per hour.

however, have indicated no detrimental effects from metallizing. Furthermore, if not metallized, the cylinders will rust and it is fairly obvious that clean aluminum will dissipate heat as well as or better than rust.

The fabric on ships so covered may be kept in better condition if waxed, though this is not essential. The question of finish brings up another point often overlooked and that is the matter of color. Red, vermilion, orange, or yellow are much more visible on the water than aluminum, gray, green, or blue. In case of a forced landing the ship is much more easily spotted if the brighter colors are used, and when taxying or at rest in a fog or haze, the possibility of collision is lessened.

Before leaving the subject of protection and, at the risk of appearing unduly repetitive, the need for common sense, care, and conscientiousness in the matter of protection is once more emphasized. The cost is not great, probably less than two or three per cent of the purchase price of the airplane at a maximum. But often the owner is so eager to get the ship overboard that he puts off all or part of the essential work of preparation until later, with the result that it is either not done at all or, by the time it is done, corrosion has already begun and continues underneath whatever protective finish may be applied. Another half day or day spent in taking the steps outlined above will frequently save hundreds of dollars at some future date.

Installation of Floats

The change-over from wheels to floats is ordinarily made at an airport which has both land and water facilities. In this case the job presents no difficulties, as a hoist and other equipment are available. However, it may be that the transfer must be made where no combination airport is convenient. Under such circumstances, the ship must, of course, either be landed on the beach or towed there.

All necessary equipment should be provided in advance to avoid unnecessary delay at the last minute. A chain hoist or a block and fall will be required, some stout rope, planks, some wooden trestles, and unless there are trees to which the hoist can be attached, a pair of long beams, 6″ x 6″ or their equivalent.

These should be bolted together at one end to form a pair of shear legs for supporting the hoist.

If the floats are purchased direct from the manufacturer, an assembly chart will be supplied with them. Otherwise, the manufacturer should be given the serial number of the floats and the type of ship on which they are to be mounted. This will enable him to furnish the necessary data. The cost will be slight and the information is highly important, as improper installation of the floats may seriously affect the performance of the ship.

The floats should be unpacked and laid on the floor or on planks, and the spreader bars (if this type of bracing is employed) assembled to them, using *plenty of grease* similar to that previously mentioned. The method of attaching the spreader bar varies with the design of the float. If spray strips are built in, they are usually on the inner side only. If the strips are on both sides or if they are lacking entirely, the floats may be interchangeable—right and left—but should be examined carefully for lack of symmetry with respect to fittings. In general, any permanent fittings are on the inner side. After the spreader bars are mounted the horizontal cross brace tie-rods should be installed, tightened, and trammeled or measured to see that they are the same length and, hence, that the floats are in proper alignment. Again, grease should be applied liberally on bolts, clevis pins, threads, and tie-rod terminals. The struts which attach the floats to the fuselage should now be bolted to the floats if the design of the fittings is such that they will not be too "floppy." Some fittings are of the ball and socket type, in which case the struts should first be fastened to the fuselage.

The ship should be hoisted high enough, so that when the floats are attached they will just clear the ground. If hoisting lugs are not provided on the airplane, it is usually best to lift it from the engine mount or the crankshaft. The tail should be supported by another hoist or a wooden trestle so that the fuselage is approximately level, and additional supports should be put under each wing tip to prevent tipping. A padded crossbar clamped to a vertical plank at each end of the bar makes a simple and convenient arrangement. The landing gear may now be removed and the floats mounted. The diagonal brace wires or struts should be checked to see that the alignment is correct

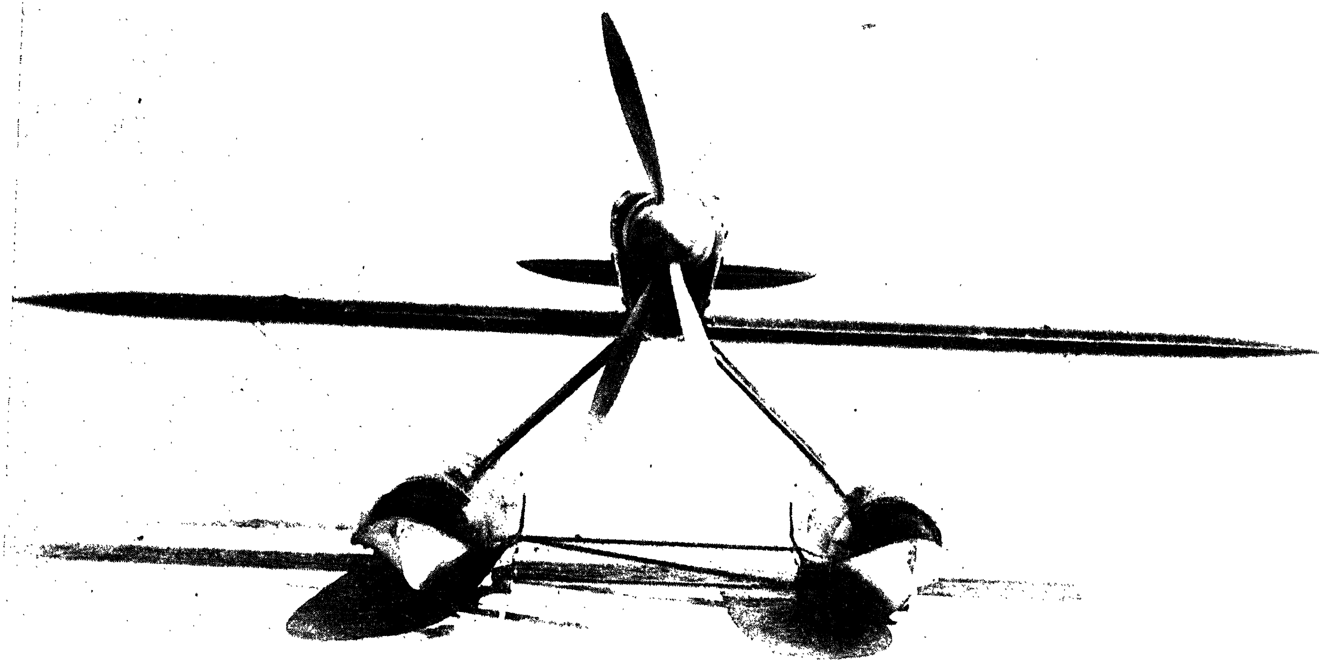


Figure 33. Front View of the Macchi-Castoldi

Note sharp Vee of float bottoms and twin propellers rotating in opposite directions to eliminate torque.

and all bolts tightened thoroughly so that there is no play. Tie-rods should be protected by friction tape or fibre washers wired in place wherever they cross to prevent rubbing. Connections should be safetied and the ship lowered onto a beaching gear or on planks placed under the keels. Blocking should be placed under the rear of the floats to eliminate the possibility of tipping while further work is going on.

The water rudders should be connected according to directions supplied by the manufacturer, and their throw checked. This should be *at least 45° on each side of neutral.* They should line up with the air rudder in the neutral position. Springs should always be installed between the rudder pedals and the water rudders, so that in case the latter are damaged by striking something in the water or should jam from ice or any other reason, the air rudder may still be used. The water rudder lifts should be put in, and the cockpit end should be located convenient to the pilot. If the rudders are not lifted when taking off and landing, the constant banging up and down wears out the swivel bolts and bearings. Also, there are other conditions, such as sailing backwards or backing into a beach, under which it is much better to have them up.

Checking

Some of the engineering considerations involved in converting landplanes into seaplanes have been discussed in Chapter IV, where it was pointed out that due to the drag of the floats in the water any lack of efficiency in engine or propeller affected the seaplane much more adversely than the corresponding landplane. Accordingly, before testing the ship just mounted on floats, the engine should be checked to see that it is delivering its rated horsepower. Cases have been known where the pitch of an adjustable propeller has been decreased so as to make the engine show the full r.p.m. even though it was badly in need of overhaul. The r.p.m. should be checked with a propeller which turns at the proper speed on an engine known to be in good condition.

After the efficiency of the engine has thus been determined and it has either been found satisfactory or put in proper shape, the ship should be flown to determine the maximum r.p.m. in the air. This is best done by flying a few feet from the water

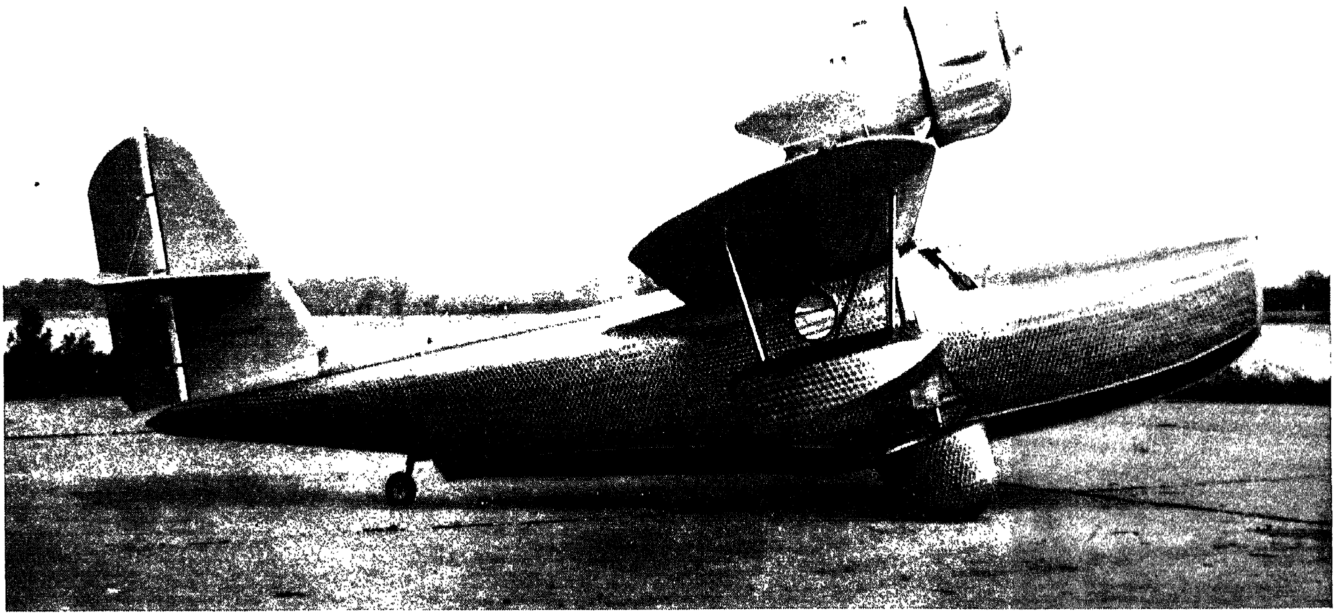


FIGURE 34. FLEETWINGS "SEABIRD" AMPHIBIAN BUILT OF STAINLESS STEEL

so that there is no likelihood of climbing or diving. The throttle should be left wide open for at least a mile and the r.p.m. noted. The pitch of the propeller should then be decreased and the test repeated, until the maximum allowable r.p.m. are attained. This corresponds to the rated r.p.m. plus 5%. Just how much the pitch will have to be decreased depends on the particular ship and engine. A rough approximation for the average airplane, however, is from 5% to 10%. This decrease in pitch can be accomplished on any of the common types of metal propellers without difficulty. The adjustable variety may be reset and the forged dural may be twisted. The work should be done at a regular propeller service station. It has been previously pointed out, and is again emphasized, that take-off will be greatly improved by increasing the propeller diameter over that used on the corresponding landplane. This, of course, calls for a different propeller, but usually an exchange can be effected at comparatively small expense and, in the case of a new ship, the manufacturer will ordinarily take care of the matter.

Another point which should be watched is the matter of exceeding the authorized gross weight. It is very easy to add extra items of equipment, such as radio, lights, flares, instruments, and the like, which weigh little when taken individually but considerable in the aggregate, so that the weight gradually creeps up without the owner's noticing it until the take-off is seriously impaired. Other occasions of overloading occur in ships with oversize gas tanks, where the extra gas capacity is intended to be used only when part of the payload is left out but instead the tanks are filled up and the full payload carried as well, and also in cases where the floats are not properly inspected and have been allowed to take on a quantity of water through unrepaired leaks. Naturally excess weight impairs landplane take-off to some extent, but as pointed out elsewhere in this book, it has a much more detrimental effect on seaplanes because of the increase in the water resistance of the floats. The maximum power is needed, as a rule, just before the ship goes on the step. The heavier the ship, the faster it must travel before planing. The resistance increases as the *square* of the speed. Hence, a small increase in weight may require a much greater proportionate increase in power.

Chapter VI

TAXYING AND SAILING

The Three Positions in Taxying

Before attempting to fly, the beginner if he is already a landplane pilot and is learning to handle seaplanes without benefit of an instructor should become thoroughly familiar with the control of the ship on the water. If he has never flown at all, preliminary practice with the instructor on the water before attempting to fly will tend to put him at ease and will accustom him to the use of the rudder and elevators and, in the case of a flying boat, the ailerons also.

Since the seaplane is the more common type, it has been used for the illustrations. The technique of handling the flying boat is practically identical, and the attitudes at various speeds correspond to those of the seaplane, so the subsequent remarks apply to either unless stated otherwise.

It should be remembered that while the engine of a landplane may be "revved up" to a fair speed before the ship starts to roll, the seaplane, unless tied, begins to move as soon as the engine is started. If the ship is on a ramp or securely tied to a raft, it may and should be warmed up while stationary, but otherwise the warming process will have to be done while taxying at idling speed. The attitude of the ship at this speed, as shown in Figures 35 and 36, is the same as when it is at rest with the engine dead. If the water rudders have sufficient movement, it will be found that the ship can be turned in a circle, of which the diameter is little more than the span of the wings. The water rudders are most effective at slow speed—slightly above idling—because they are then working in undisturbed water. At high speeds the step of the float churns up the water and the rudders are less efficient; also, they tend to swing up or retract due to the force of the water. The student should spend some time taxying at slow speeds and in calm weather, until he has a good idea

of the maneuverability of the ship and how near he can come to placing it where he wishes.

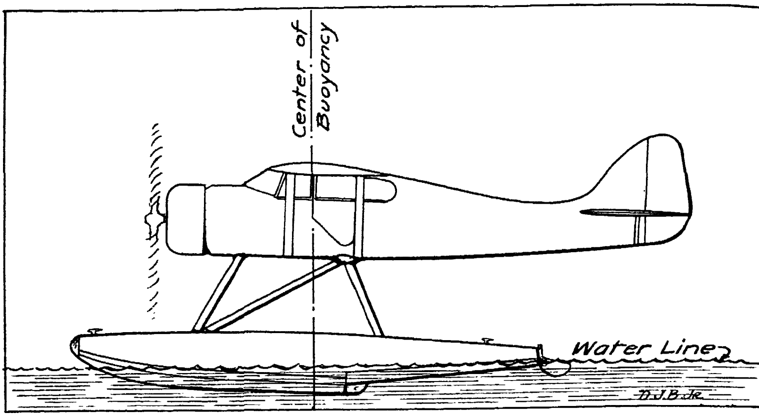


FIGURE 35. THE IDLING POSITION

Having become familiar with the idling position, he should proceed to the second or "nose-up" attitude. The control column should be held hard back and the throttle opened slowly.

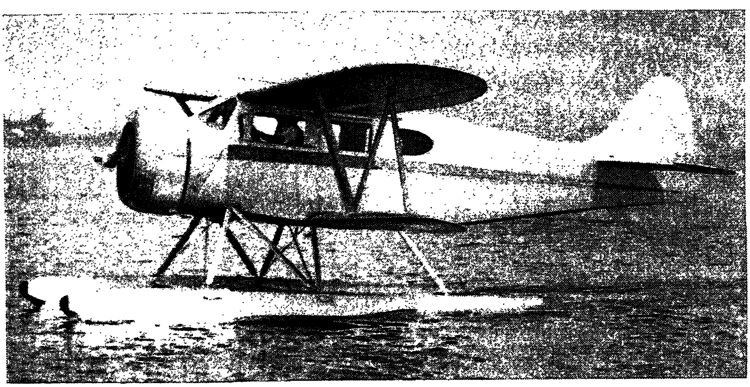


FIGURE 36. WACO CABIN SEAPLANE—IDLING

As the speed increases, the force of the water on the forward part of the bottom causes the bow to rise until the ship assumes the position shown in Figures 37 and 38. At first, the beginner should keep the r.p.m. down to 60% of the maximum. The bow will go up whether the controls are held back or left

in neutral, but as the idea is to get the nose as high as possible, the hard-back position is preferable. The nose-up attitude does

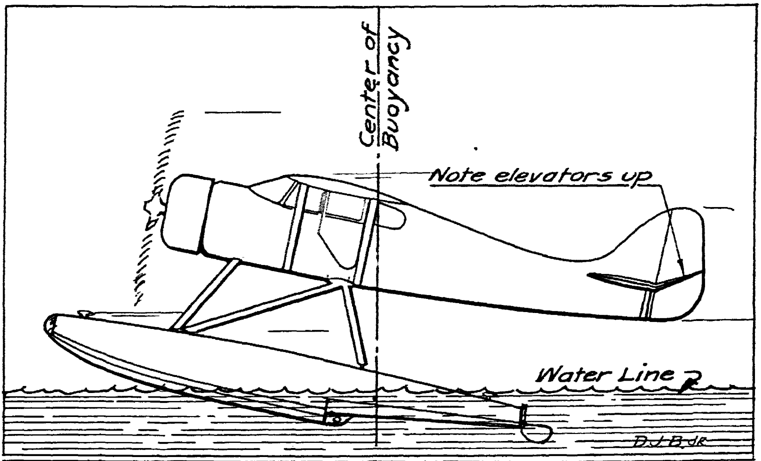


FIGURE 37. THE "MAXIMUM NOSE-UP" POSITION

not allow as much visibility as might be desired on most ships, but in the case of the twin-float seaplane it protects the pro-

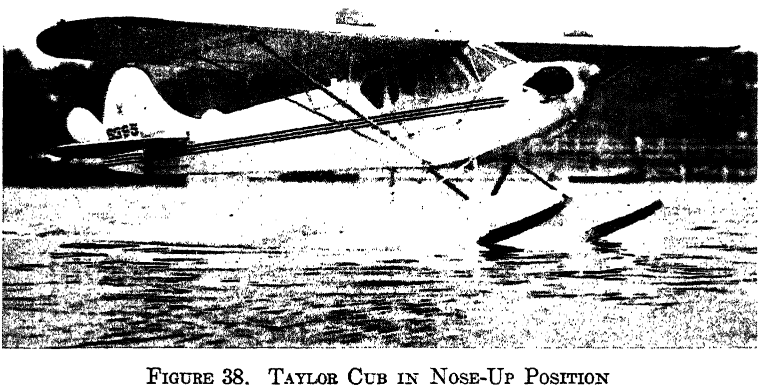


FIGURE 38. TAYLOR CUB IN NOSE-UP POSITION

peller from spray better than any other. The worst position from the standpoint of propeller abuse is halfway between nose-up and idling, as the increased speed kicks up spray and the

propeller is not high enough to clear it. Taxying in this halfway position usually marks the inexperienced seaplane pilot.

In the nose-up position, if taxying across the wind, most ships will show a tendency to turn *down wind.* The reason for this will be understood if a comparison is made between Figures 35 and 37. In turning, the ships tend to rotate about a vertical axis passing through or near the center of buoyancy (see glossary). In the "at rest" or idling position there is more side area or lateral fin area behind the c.b. than in front of it. Hence, when the wind strikes the side of the ship it tends to blow the tail around, and the plane weathercocks or points its nose into the wind. This characteristic of seaplanes is sometimes rather startling to a landplane pilot who has been accustomed to brakes, as it gives him a nervous feeling that the ship is getting away from him. However, he will soon become accustomed to it and will realize that any seaworthy seaplane must perforce weathercock or it will not *be* seaworthy. Furthermore, the quality of tending to point into the wind is very essential in sailing, as later described. When in the nose-up position there is more lateral fin area in front of the c.b. than behind it; hence the nose tries to go *down* wind. This characteristic is very valuable when taxying across a strong wind with a ship which has none too much rudder, as the steering may be done practically with the throttle. By opening the throttle the nose is brought up and the ship swings down wind; by closing it the reverse is accomplished.

The third position is illustrated in Figures 39, 40, 43 and 2. This shows the ship running "on the step" or planing. The minimum speed required to maintain this position varies with the airplane. In general, it is twenty-five to thirty m.p.h. The maximum which can be reached is, of course, just under take-off speed. The procedure employed in putting the ship on the step consists of holding the controls hard back and opening the throttle completely. The water rudders are lifted and the stick or wheel is held back until the nose refuses to go higher and then is allowed to move forward to a point slightly back of neutral in the case of some ships. In others, it is a help to push the control past neutral and then bring it to the slightly back position. Which method produces the quickest results must be determined by experiment with the particular ship in question.

As the plane rocks over on the step, it assumes an approximately level position and the speed increases rapidly. There is also a feeling of lightness which is soon recognized. As soon as the

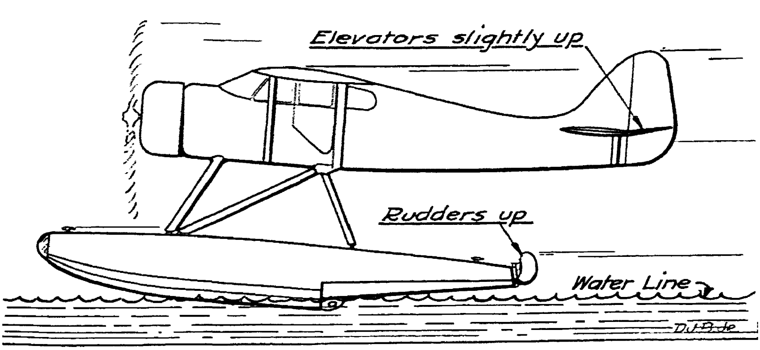


FIGURE 39. RUNNING ON THE STEP

horizontal attitude has been reached the throttle must be partly closed; otherwise the speed will increase until the ship takes off.

FIGURE 40. DOUGLAS OBSERVATION ON THE STEP

Usually about 65% to 70% of the maximum r.p.m. will keep it on the step without taking it into the air. The beginner, however, should err on the low side rather than the high in respect to the r.p.m. for he is not ready to take off as yet. As stated

above, while running on the step a slight back pressure should be maintained on the control column. In case the ship shows a

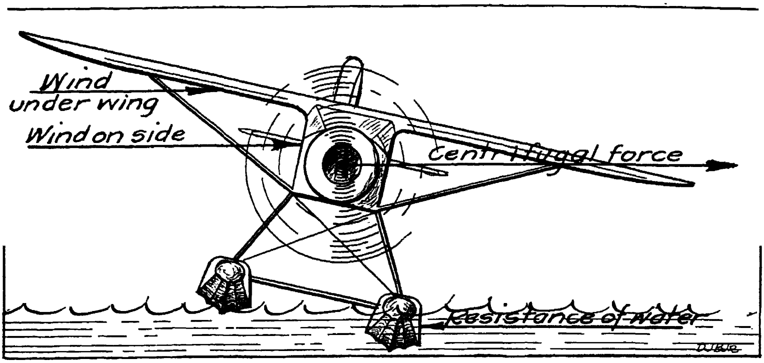


FIGURE 41. FORCES ON SEAPLANE WHEN TURNING INTO THE WIND

tendency to porpoise, or rock fore and aft—a trick much more common in boats than in seaplanes—the rocking may be checked

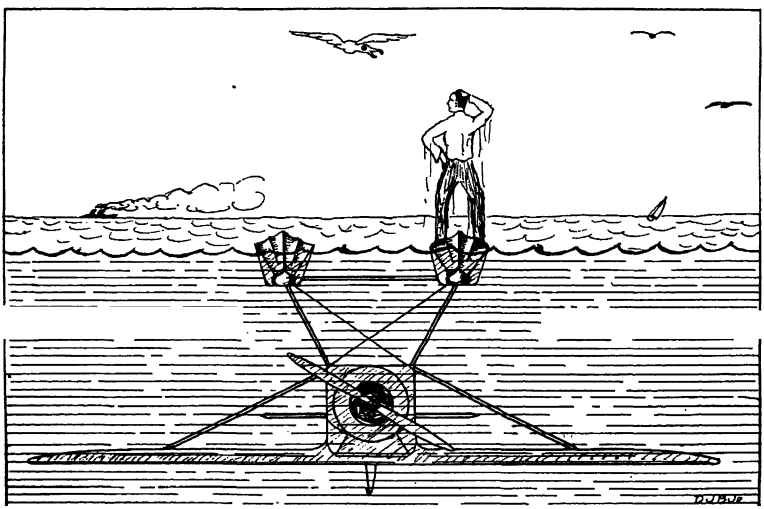


FIGURE 42. THE EMBARRASSING RESULT OF TURNING INTO THE WIND TOO ABRUPTLY

by increasing the back pressure, rather than by attempting to push the stick or wheel ahead as the bow comes up and pull it back as the nose drops, which would only make the porpoising

worse because most pilots are always just one move behind the ship.

TURNS

So far only taxying in a straight line has been discussed. Turning at low speed in a light wind amounts to nothing more than applying rudder on the side toward which the turn is to be made. As the strength of the wind increases, however, different technique is required and certain cautions must be observed. One of these is *never turn into the wind quickly when taxying down wind.* The faster the ship is moving and the stronger the wind, the more necessary it becomes to follow this rule. A study of Figure 41 will show the reasons. As the ship swings across the wind, the thing that keeps it from continuing to move on its former path is the resistance of the water on the side of the floats. Centrifugal force acting horizontally through the center of gravity tends to make the upper part of the ship move toward the outside of the turn. The wind, blowing against the side of the fuselage and vertical tail surfaces, acts in the same direction as centrifugal force, and the two combined will make the seaplane heel over on the lee side. As it heels, the wing on the other side comes up and the wind gets under it, whereas the leeward wing is blanketed by the fuselage and gets no lift from the wind. If the magnitude of the forces is sufficient, the consequences illustrated in Figure 42 are bound to follow.

Any danger of such a mishap can be avoided, however, by making the turn properly, as follows: throttle the engine to its lowest idling speed; allow the ship to slow down as much as possible; then start the turn by applying a little rudder on the side toward which the turn is to be made, neutralizing the rudder as soon as the ship has swung very slightly off the straight down-wind course. If the swing tends to become too rapid, *opposite* rudder should be applied to retard the speed of turning; in other words, in a left turn slow it down with right rudder, and vice versa. As experience is gained, the pilot soon learns just how abruptly he can weathercock, but the beginner should proceed with extreme caution. A flying boat or single-float seaplane is less likely to capsize under these conditions, due to the wing-tip floats and, in the case of the boat, the fact that the center of gravity and the side area struck by the wind are both

much lower. However, boats have also been known to turn over under such conditions.

Turns in a multiengine ship are, of course, materially assisted by using one outboard engine while the others are throttled. The ship can be steered entirely with the engines. However, it is not contemplated that such ships will be handled by anyone not already a first-class seaplane and flying boat pilot.

In making a down-wind turn in a stiff breeze, it may be found that the water rudders do not give sufficient control to force the ship out of the wind at idling speed. This is due to two causes. The first and most obvious is that the ship has a much stronger tendency to weathercock or point into the wind. The second is that the force of the wind may partly or completely offset the pull of the propeller, so that the ship has little or no forward speed. In fact, instructions will be given below how to make the ship move backward with the engine running. Naturally, if there is little forward speed, the ship lacks "steerage way" or sufficient motion through the water to render the water rudders effective; and it is at this time that the greatest effectiveness is needed due to the stronger weathercocking tendency. When difficulty in turning is experienced, it is sometimes feasible to start the turn in one direction; then when the ship refuses to swing further, apply full rudder the other way. The momentum gained in this manner will often carry the plane around. There is rarely any danger of making a *down-wind* turn too quickly unless the wind is very light, though there are times—in a gale and high sea—when it is not advisable to turn at all. This condition is discussed below.

When the strength of the wind is such that the ship cannot be turned down wind at idling speed, the stick or wheel should be held back, full rudder applied, and the throttle opened enough to bring the nose up. This puts more lateral area forward of the center of buoyancy than behind it (as explained before) and permits the turn to be made with less difficulty.

Gentle turns may be made with a twin-float seaplane while running on the step, but great care should be used not to make them too sharp. A radius of several hundred feet, depending on the particular airplane, is the minimum for the beginner. Once a seaplane begins to tip there is nothing to stop it except rudder in the opposite direction, and the relatively high speed when on

the step calls for much quicker reactions on the part of the pilot than when he is taxying normally.

In the case of the flying boat, step turns are less likely to cause trouble, for as soon as the wing on the outside of the turn drops appreciably, the wing-tip float strikes the water and, if the float is properly designed, it throws the wing back up—or at least tends to prevent further tipping. In addition, since

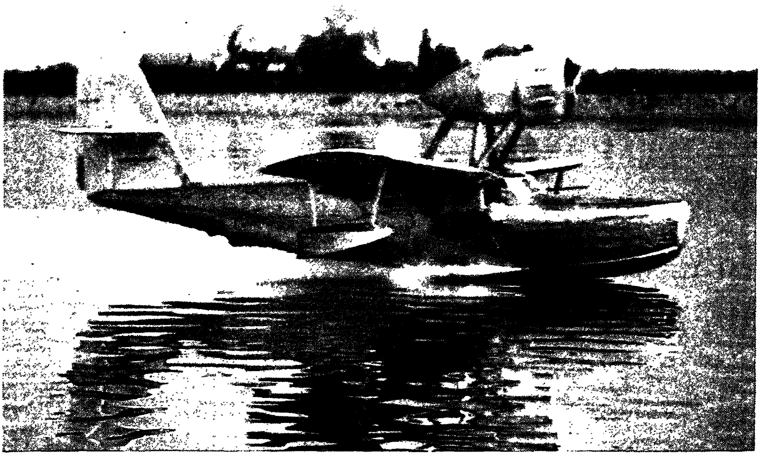


FIGURE 43. FLEETWINGS "SEABIRD" TAXYING ON THE STEP

the boat is supported on the water at one point instead of two, it is much more responsive to the ailerons. If these are sufficiently effective, the ship may be banked while making a turn on the step just as though it were in the air.

On first thought it may seem that there is no occasion for making turns while running on the step. There are times, however, when it is a valuable and even indispensable maneuver. Hence, it should be practiced, so that when the need arises the pilot will feel at ease. Further discussion of the subject will be found under "Take-offs" in Chapter VIII.

Occasionally, due to conditions of wind and water, it is unsafe to attempt to make a turn at any speed. For example, if the wind velocity is considerable—say over 40 m.p.h.—and the waves are high, as the ship turns broadside to the wind, the upwind float may be lifted by the crest of a wave while the other

float is in the trough, thus tilting the ship so that the wind gets under the wing at the same time that it is blowing against the side. The condition then is similar to that shown in Figure 41 except for the centrifugal force, which is acting in a direction opposite to the force of the wind. Unfortunately, however, the magnitude of the centrifugal force depends upon the speed with which the turn is made, and since it is impossible to turn *down* wind very quickly under the conditions outlined, the correcting or balancing effect is negligible. On the other hand, if the turn is half-made and the pilot changes his mind and decides not to complete the maneuver, then all the forces shown in Figure 41 are acting. Hence, if the ship shows a pronounced tendency to heel over when starting the turn, the engine should be throttled before the course has been changed more than 45°, the full rudder *left on* so as to check the weathercocking. The only other recourse is to open the throttle wide and attempt to go on around fast enough, so that the centrifugal force developed is sufficient to counteract the effect of the wind. Choice of procedure depends on the type of ship, the condition of the water, and, most of all, on the experience of the pilot. The best thing, if there is any doubt, is not to turn at all but place the ship where desired as explained below.

Sailing

Many occasions arise when it is desired to move the ship into a position behind or to one side of its location; yet, because of weather conditions or limited space, it is not practicable to attempt a turn. If there is any breeze at all, the ship may be sailed into quarters which to the inexperienced might seem impossibly cramped. Of course, if there is *absolutely* no wind and no room to turn, the paddle mentioned in Chapter III is used to point the ship in the desired direction, after which the engine is started. But, with the faintest breath of air, a combination of knowledge, patience, and—sometimes—the use of the engine will put the ship in any space large enough to hold it, assuming, naturally, a depth of water sufficient for flotation and no appreciable tide or current. The effect of strong currents is discussed in Chapter VII.

With the engine dead and a light wind, a seaplane will move

in the direction the tail is pointed due to the keel effect of the floats. In a strong wind it will probably move in the direction the

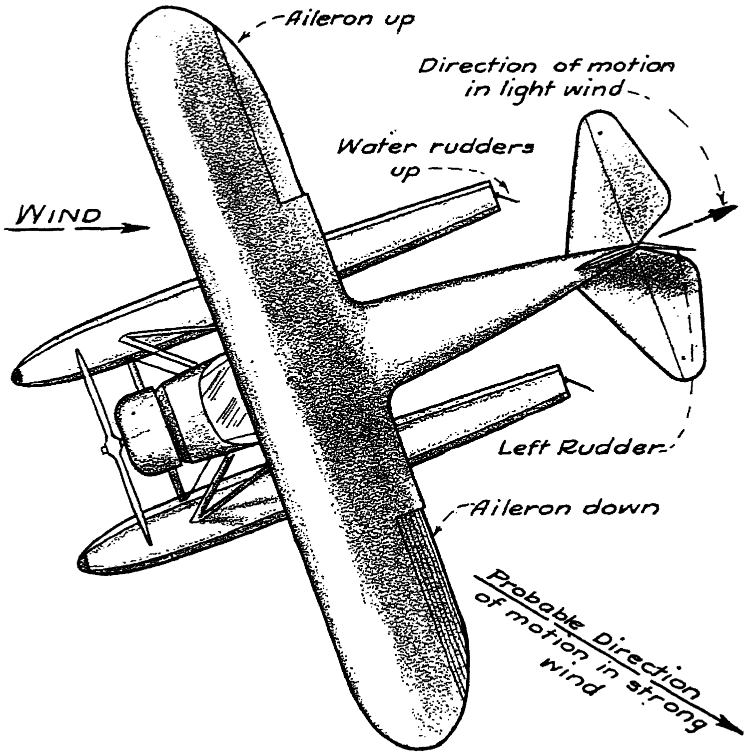


FIGURE 44. SAILING A SEAPLANE—POWER OFF

nose is pointed. In either case the rudder must be used and the ailerons will usually help. Also, lowering the flaps and opening the cabin doors will increase the air resistance and thus add to the effect of the wind.

Figure 44 shows the procedure when it is desired to move a seaplane backward and to the right in a gentle breeze with the engine off. The water rudders are lifted, the elevators pulled up, right aileron and left rudder are applied, and if more "sail area" is desired, the flaps are pulled down and the doors opened. The ship will swing off wind and travel along the path indicated in the diagram. However, if the wind is strong enough to offset the keel effect of the floats, the ship will move backward

to the *left* with the controls in the same position. Just how much wind velocity is necessary to cause this change of direction de-

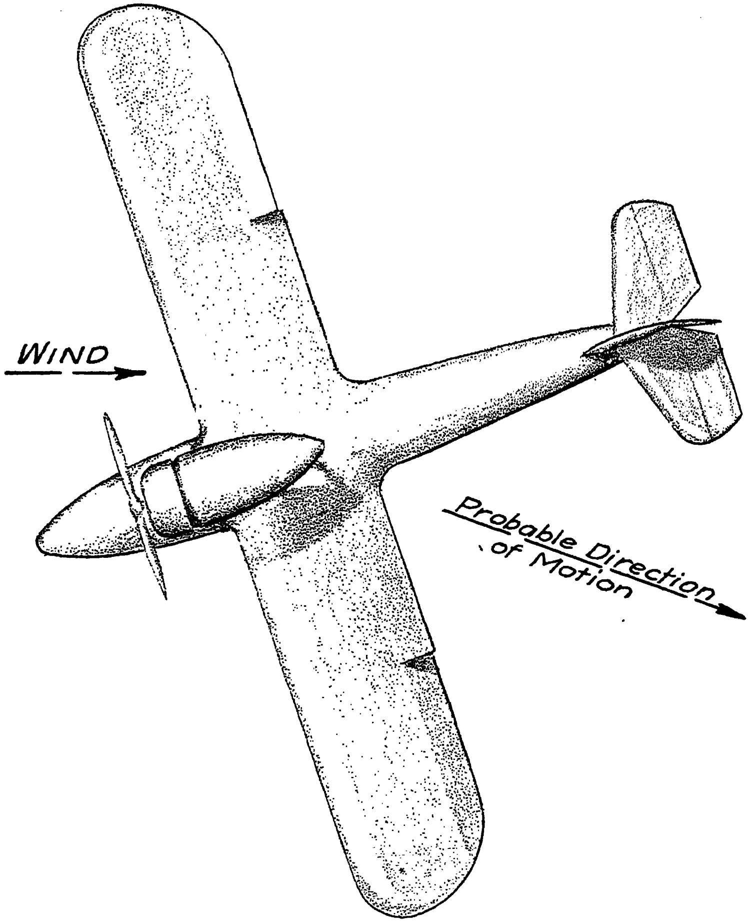


FIGURE 45. SAILING A FLYING BOAT—POWER OFF

pends on the individual airplane. The relative size of the floats, fuselage, and control surfaces all affect the situation; but a little experimenting will soon settle the problem.

Almost any flying boat, if the engine is dead, will sail backwards in the direction the nose is pointed, regardless of the

strength of the wind, as the hull does not ordinarily provide as much keel effect in proportion to its size as the floats do. Figure

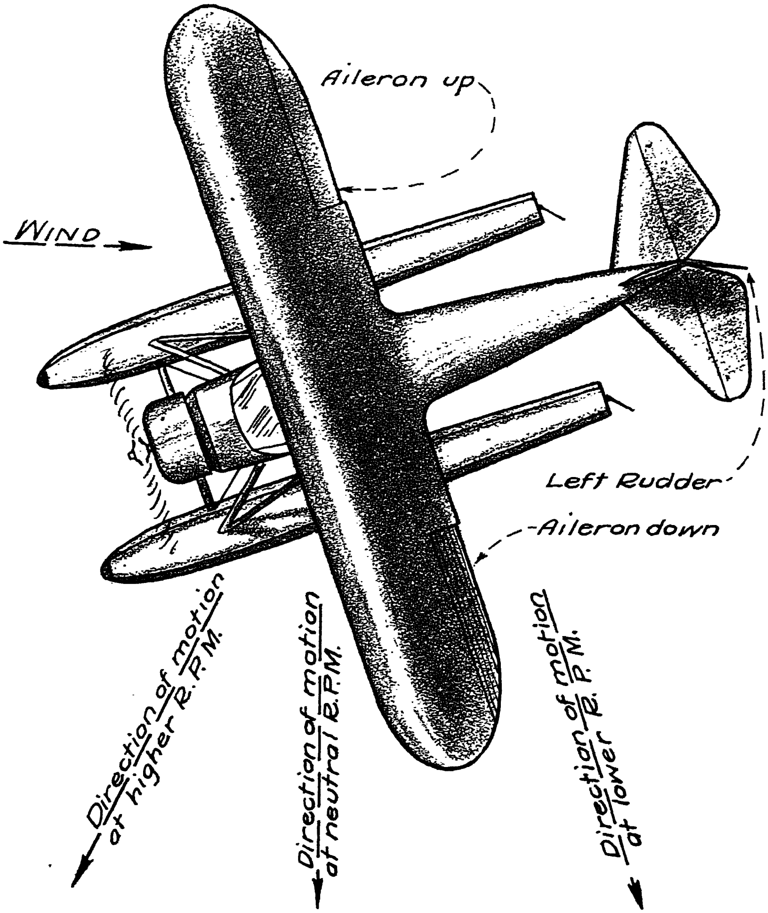


FIGURE 46. SAILING A SEAPLANE—POWER ON

45 illustrates the direction of motion which may be expected with a given setting of the controls. Note position of rudder and ailerons.

If the problem is to move the ship (whether seaplane or boat) directly sideways, the engine is started and allowed to run just fast enough to prevent drifting backwards—called *neutral* r.p.m. on diagram. In light winds this, of course, requires very low idling speed. The nose is pointed, by the use of the rudder

and ailerons as before, in the direction it is desired to move. Water rudders need not be lifted, as they have little effect unless the ship is moving either forward or backward. By increasing the r.p.m. slightly and keeping the controls in the same position, the ship will move diagonally forward in the direction the nose is pointed. In this case it will help a little if the water rudders are left down. If the wind is strong enough, by decreasing the r.p.m. the ship may be moved diagonally backward. The controls are still the same, except that it would be better to lift the water rudders. These various motions are illustrated in Figure 46. If it is desired to move sideways when the wind is so light that the ship goes ahead even with the throttle completely closed, the engine may be slowed down still more by turning the switch off and on. If even this does not solve the problem, the ship may be tacked very much like a sailboat by alternately sailing and taxying as shown in Figure 47. Sailing is an indispensable part of seaplane handling and should be practiced until the pilot is thoroughly familiar with the characteristics of the particular ship he is flying.

Chapter VII

APPROACH AND DEPARTURE

General

Prior to approaching any type of base, it should be looked over thoroughly by the pilot before he gets in close enough to be hampered by obstructions. The direction of the wind and tide or current, if any, should be studied and the probable effect determined. Bear in mind that if left to its own devices the ship will always point into the wind, and that it can always be turned into the wind without difficulty. Hence, it is perfectly safe to pass close to an object if the airplane is on the windward side, since if it appears that the clearance is going to be insufficient a turn away from the obstruction (or into the wind) may easily be made. On the other hand, ample room should be allowed when passing to leeward, for if the wind is strong and the ship swings, it will swing right into the obstacle.

Although the ship when let alone will point into the wind, it is highly probable that it will *move with the tide* if the latter has appreciable velocity. When a pilot who has always flown from lakes or bays encounters this condition, situations are often produced which are quite amusing to everyone except the unhappy flyer, who taxies straight into the wind close to an obstruction and blissfully cuts his motor, expecting to drift back, only to find to his great dismay that he continues to bear down on the object with little decrease of speed, and there is nothing he can do about it. How much wind is necessary to offset a given speed of tide or current again depends on the airplane, for, if the plane is light and presents a large surface to the wind, it corresponds to large sail area on a light sailboat and vice versa. In general, however (and in the case of an airplane of average proportions), a current of 6 m.p.h. will more than offset a wind of 30 m.p.h. In other words, under such conditions the ship will move *against* the wind. The position of any boats which may be at anchor

in the vicinity is a fairly reliable indication of what may be expected. If the engine is off, the airplane will move in a direction *opposite* to that in which the boats point, that is, the movement will be towards the stern of the boats.

If the wind is of sufficient strength to render control of the ship difficult, the approach to any ramp or raft should be either *directly* down wind or directly into the wind, making due allowance for tide or current if any exists. This eliminates the need

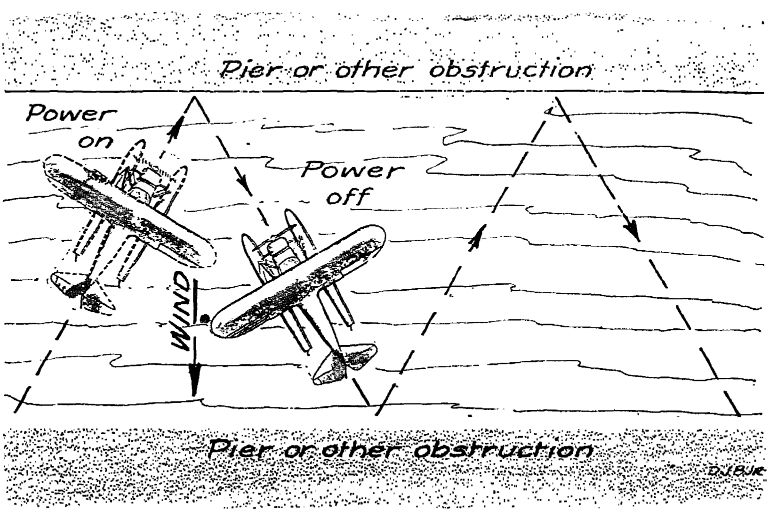


FIGURE 47. TACKING IN NARROW QUARTERS

for excessive speed, with its possible accompanying complications. The actual contact with the landing point is explained below.

RAMPS

If the ramp is of the turntable type, a seaplane should be brought in contact with it at idling speed and, as soon as the floats touch, given enough throttle to slide it up to the center of the turntable. This may take almost "full gun." After reaching the approximate center of the table the stick or wheel should be pushed all the way forward and the r.p.m. reduced to about 50% of the maximum. This will keep the ship from rocking back on the tail of the floats until a mechanic blocks them up

or rotates the turntable 90°. The passengers are discharged or taken on, as the case may be, after which the table is rotated another 90°, pointing the ship toward the water. The ramp may or may not have been lifted. If it has been, it will now be lowered. The water rudders should be raised and the throttle opened gently at first and then more until the ship begins to slide down, at which point it should be closed to prevent picking up too much speed. Rocking the ship with the elevators will

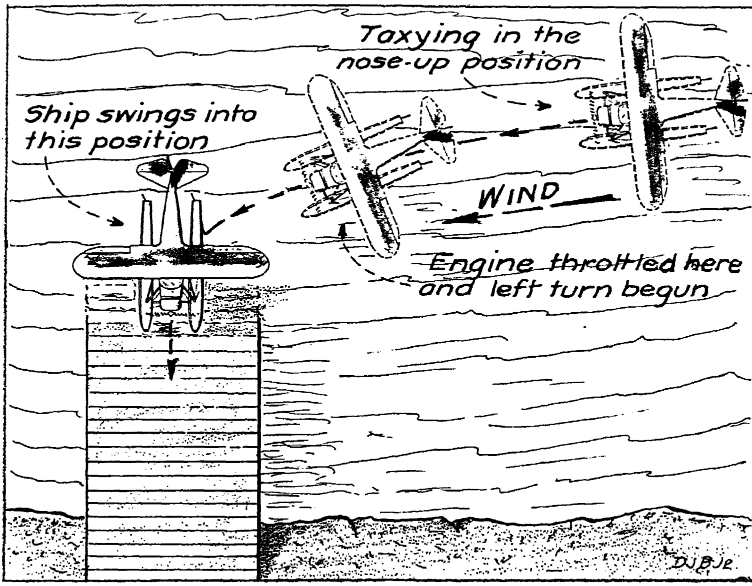


FIGURE 48. MAKING A RAMP WITH CROSS WIND

help to get it started, but this is seldom necessary on the turntable type of ramp. As the bows touch the water, the control should be pushed ahead and the throttle opened abruptly for a second to prevent the sterns of the floats from striking the ramp, unless a mechanic is holding the tail up.

If the wind is blowing toward the ramp, whether turntable or fixed type, the approach should be made *directly* down-wind as mentioned above. This often means that the course is at an angle to the ramp, but contact should be made with both floats at the same time. This is accomplished by following the diagonal path until a few feet away from the mark, and then turning

slightly, so that as the ship begins to weathercock, it will come in contact with the ramp just as it is pointing straight in. This is illustrated in Figure 48, and calls for fairly good judgment as to the proper point to start the turn. When nicely done the contact will be quite gentle. In general, however, if the turn is made too soon and the ship swings further than was intended, it is better to open the throttle and strike the ramp with both floats at fair speed than to let one get on ahead of the other; for if this occurs, the ship will abruptly weathercock, and there is a possibility of rather serious damage to the float, particularly if the keel happens to get into a crack.

If the wind is strong and directly across the ramp, it is inadvisable to try to go up, unless there is an assistant on shore. The ship should then be taxied into the wind and across the slope as close in as possible. The assistant may then catch the wing and hold it while the pilot applies rudder on the proper side and opens the throttle. The helper may have to hold the wing as the ship slides up to prevent weathercocking.

Going out on a fixed ramp is the same as on the turntable, except that the ship is slid on up until well clear of the water, where some type of beaching or handling gear is put on. In leaving the fixed ramp, the surface must be wet or the keels will not slide. When coming out of the water enough of it usually runs off the floats to take care of the situation. If rocking the ship with the elevators with full power on is not sufficiently effective in starting to slide, alternately pushing ahead and pulling back on one wing tip will usually do the trick. The pilot should be alert to close the throttle as soon as the ship moves however, or excessive speed may result.

If the ramp is concrete, the seaplane should never be brought in without helpers on shore. The beaching gear must be put on while the ship is still floating as the concrete is ruinous to keels.

In the case of amphibians the approach to ramps is the same as with the seaplane. Just before contact the wheels are put down and the ship taxied out under its own power. On turntables the wheels should be chocked both in front and behind, and the front chocks left in place until the pilot signals that he is ready to enter the water.

If a marine railway or "Boston" dolly is to be used, the carriage should be lowered until the upper edge is just above the

water. The ship is then taxied onto the platform just as though it were a ramp and the throttle closed as soon as the floats are well-grounded. The carriage is hauled out of the water and the pilot has no further hand in the operation.

Rafts

As stated heretofore the word *raft* is used for want of a better term and to avoid confusion. It refers to a substantial floating platform such as may be seen at any yacht club and which is commonly called a *float*. The reason for not using the usual name is obvious.

The approach to a raft should always be made up-wind if possible, for in making contact the ship must be brought to a stop, or nearly so, as the bow touches. The ideal procedure in the case of a seaplane is to come alongside of the raft with one wing projecting over it. In this case a helper can catch the wing or the pilot can step out onto the float and thence to the raft and secure the ship at bow and stern. The engine should, of course, be idled for the last few hundred feet of the approach to allow proper cooling off, so that when the switch is cut the propeller will not continue to kick over, endangering the life of anyone on the raft as well as making it difficult to hold the ship. If the ship is of the boat type, the best contact is bow first. If it is desired to come alongside of the raft as described above, there *must* be someone there to lift the wing and prevent damage to the wing-tip float. The amphibian has the advantage on the ramp, but the seaplane, as a rule, is much more convenient around a raft.

In using rafts a thorough knowledge of sailing is necessary. Naturally, it is impossible to give detailed instructions for every condition which may arise, but three typical approaches under adverse circumstances are shown in Figures 49, 50, and 51. The location is an actual one. The diagrams have notes which should make the procedure clear without further discussion. Familiarity with these illustrations and the technique of sailing, a reasonable amount of thought, and, above all, patience will enable the beginner to put his ship anywhere he wants without damage.

When leaving a raft, if there is an assistant available, the ship should be turned so that it points toward open water before

starting the engine. If there is no help, the pilot must turn it or else cast off and drift back far enough to allow *ample* room for making the turn under power, after which the engine is

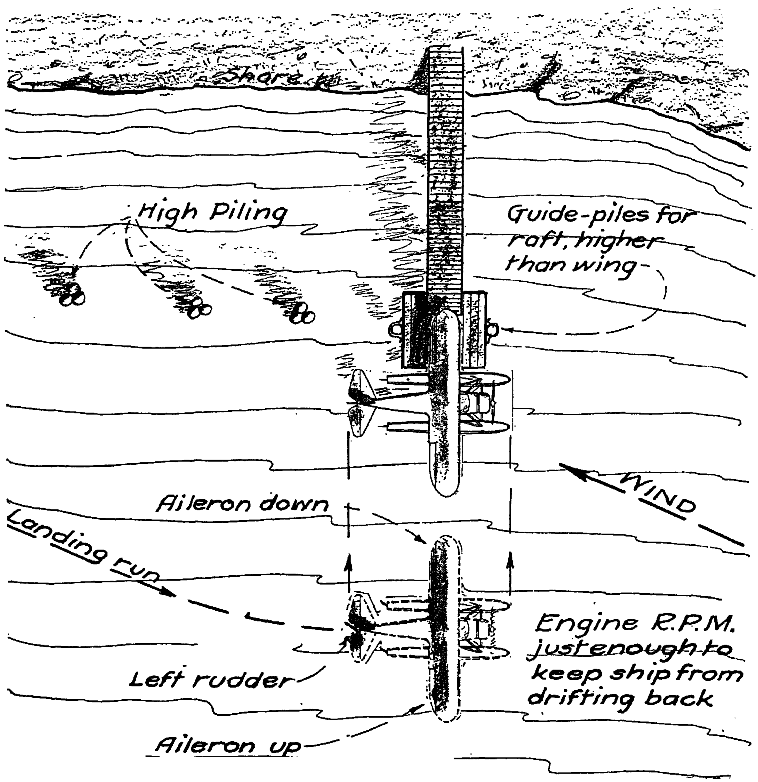


FIGURE 49. SAILING INTO RAFT WITH QUARTERING HEAD WIND

started. In this connection it should be borne in mind that the water rudders have no effect until the ship begins to move. The canoe paddle (described before) is often helpful, especially if there is no wind at all.

DOCKS AND PIERS

The approach to a dock or pier must be made with extreme caution as they are rather solid things to hit, and unless used regularly by seaplanes or small water craft, are not likely to have protecting fenders or bumpers of soft material. If they

are lower than the wing, the same methods of contact may be used as with rafts; but if higher, the approach should always be made directly into the wind, unless there is a capable helper standing by to hold the wings clear. Many docks are supported on piling which leaves room for the floats to run underneath and allow the propeller to smack the structure. If such a condition exists, care should be taken either to stop short of the dock or else to strike the piling with the bumpers on the bow. Tying up to a dock also presents problems. These will be taken up in Chapter XI along with other methods of securing the ship.

Beaches

A firm, sandy beach, free from rocks or surf and with a good slope makes about as convenient a ready-made means for going ashore as can be found. The chief precaution to be observed is to watch the tide, as one can be left high and dry in half an hour or less.

If the wind is on-shore—that is, blowing from the water toward the land—the seaplane should be taxied in fairly close (but not close enough to risk running aground), turned into the wind, and the water rudders lifted. It will then sail back until the floats strike bottom. The pilot may now go ashore, lift the tail of the ship, and drag it back. In most cases this will enable the passengers to step from the stern of the floats onto dry land, and the airplane is set pointing out, ready for a take-off. If the tide is going out, someone must stand by and keep pushing the ship out. If there is an incoming tide all that is necessary is to take a line from the rear of the ship to some point beyond high-water mark and fasten it there either with the anchor or by some other means. However, it is not good practice to leave a ship on the beach unwatched.

If the wind is off-shore, the ship must be taxied in until the bows of the floats run aground. After the passengers have disembarked, it is usually good practice to turn the ship around, especially if the tide is going out. The same precautions in regard to pushing it out with the tide and leaving it unguarded apply here also.

A wind parallel to the shore is the least desirable. In this case it is usually best to approach head on and ground the floats

firmly before getting out, as the tendency will be to swing into the wind. A line should be run to the rear cleat on the windward side and carried around the rear struts. When the ship is pushed back and allowed to swing into the wind, this windward float will be the furthest from the beach and may be pulled in from shore, thus grounding the stern of both floats.

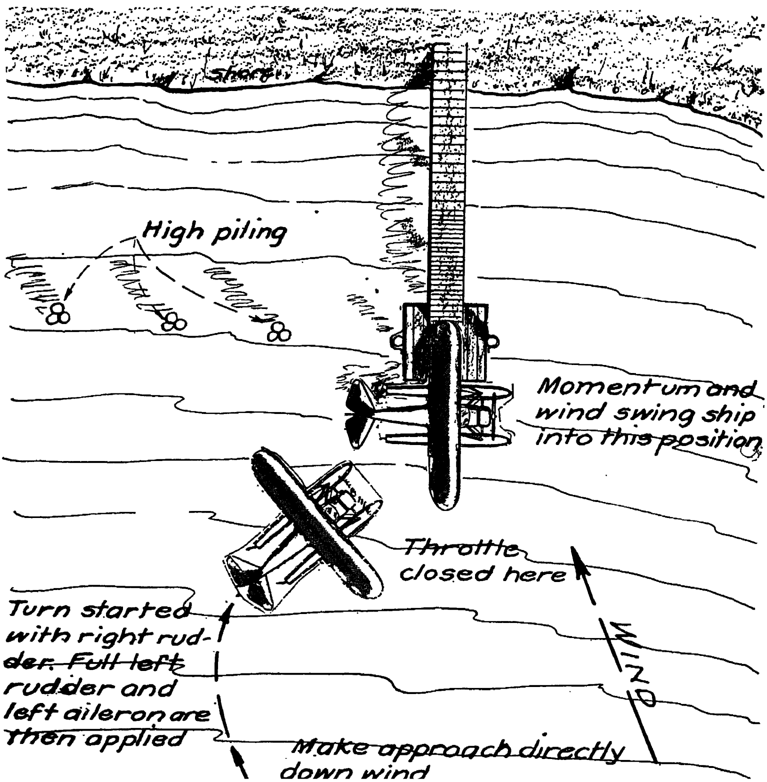


Figure 50. Approach to Raft with On-Shore Wind

In approaching beaches of any description, a sharp lookout should be kept for rocks. If these are only slightly submerged, they may usually be detected by a roughness of the water over them. If they are too deep for this, there is no way of locating them. Needless to say, if the slightest scrape is felt on the bottom, the switch should be cut immediately and an investigation made.

Obviously, in beaching an amphibian the logical procedure is to put the wheels down and taxi out. Unless the beach is solid, however, it is better not to attempt it, for to get stuck in the mud half in and half out of the water is an extremely annoying predicament. If there is any doubt about the solidity of the beach, the wheels should be left up and the ship brought in on the keel. Whether it should come in nose first or tail first depends on the means of exit. In any case, just as the seaplane, it should be turned around if necessary and pointed away from shore immediately after disembarking.

Loading or Unloading from Boats

There are times when it is impossible to unload either at a dock or beach, and it becomes necessary to use a motor or rowboat for the transfer. It is important, of course, that the water craft (especially if equipped with power) be in capable hands and that great care be used in making the contact; otherwise it is quite likely that damage to floats or hulls will result.

If the airplane is a flying boat, the point of contact should be as near as possible to the most convenient exit, and if there is much wind the two crafts should be connected by a line to avoid their drifting away from each other. In the case of a seaplane the procedure varies somewhat with the wind velocity and the size of the motorboat. In calm water or with a small boat it is usually better to lay the boat alongside of the float so that the passengers may leave in the customary manner. In a strong wind, however, if the motorboat is large enough, the best plan is to bring it across the bows of the two floats and pass a line from the bow of the motorboat around the mooring cleats on both floats and thence to the stern of the powerboat. The line is then drawn tight so that the float bumpers are held snugly against the side of the boat. This makes the two craft move together in choppy water, protects either from damage, and, to a large extent, prevents the passengers from being splashed with spray as they walk on the forward deck of the floats.

Picking up Moorings

In getting hold of a mooring buoy a boat hook is a great help. The combination boat hook and paddle previously mentioned

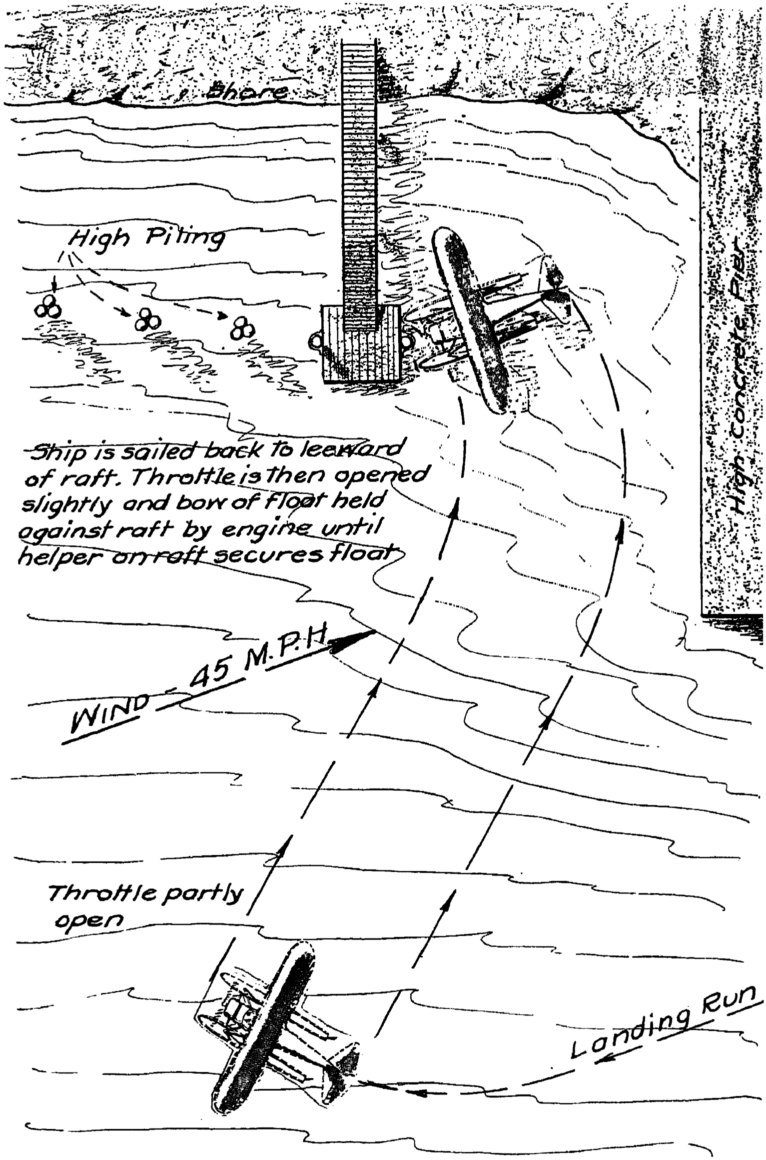


FIGURE 51. SAILING INTO CLOSE QUARTERS IN A HIGH WIND

will be found highly satisfactory. A certain amount of judgment as to how far the ship will coast with the engine off is required if the pilot has to do the job without assistance, as he will have to cut the switch and then get down on the float while the buoy is still within reach.

The engine should be idling long enough during the approach to allow it to cool, so that when the switch is turned off the propeller will stop and remain stopped. Boat hook and mooring line should be gotten out and left in easy reach. The ship should be taxied dead into the wind and steered, so that the mooring buoy will be on the outside of whichever float the pilot expects to use—probably the left—and as close as possible. Such buoys are usually padded to prevent damage if bumped. The switch should be cut, making due allowance for the momentum of the ship and the force of the wind. The pilot then gets down on the float with boat hook and line, picks up the buoy and ties on to the mooring cleat. If the stay is to be temporary and the wind is not unduly strong, there is no need of using more than the one mooring cleat; but if the ship is to be left over night or for any protracted period, a bridle should be rigged and other precautions taken as described under "Mooring" in Chapter XI.

CHAPTER VIII

TAKE-OFFS

GENERAL

The question is often asked: "Which is the harder to fly, a landplane or a seaplane?" In drawing this comparison it may be said that in the take-off the seaplane calls for somewhat more skill than the landplane; in flight there is no difference; and in landing, the seaplane presents much less difficulty.

The landplane is usually flown from at least approximately level ground, with few or no obstacles to keep clear of. Furthermore, such obstructions as may exist are usually fixed. Every take-off with a seaplane is likely to be different as regards the condition of the water; then too, there are often boats moving in front of the ship, and other floating objects which must be watched out for, so that the seaplane pilot must be constantly on the alert. An overload has little effect on the landplane except to increase the take-off run, whereas in glassy water an overloaded seaplane may require considerable jockeying to get it on the step or into the air. Under good conditions, however, it is just as easy to get a seaplane off as it is a landplane. In fact, with normal wind and water, many seaplanes may be safely taken off without touching the stick or wheel from the moment the throttle is opened. This is a trick which in the case of the landplane would be hazardous, to say the least. The proper technique in taking off is discussed fully below.

In the air, few pilots would know from the feel of the ship whether it was equipped with floats or wheels, or, for that matter, whether they were in a flying boat, a seaplane, or a landplane. The only difference that is likely to be noticed between wheels and floats is that the float-equipped ship is likely to require somewhat less aileron to maintain a steep side-slip.

In landing, the seaplane has all the advantage. A landplane must make contact with the ground in one position only—"three

points"—or it is not considered a perfect landing. A seaplane or flying boat will make a good landing in any attitude—from one in which the nose is slightly above cruising position to full stall, providing the water is smooth. Landplanes must always be "put down" in a more or less restricted area. The seaplane, as a rule, has unlimited space, and "spot" landings are made by choice rather than necessity. In student work, the seaplane shows up better by comparison than anywhere else, since the biggest part of instruction is teaching the student to land. In practicing landings in a landplane, it is necessary to circle the field every time, so that twenty landings per hour is an excellent average. With the seaplane, the student flies down wind as far as desired and then turns into the wind and makes landings every few hundred yards on the way back, often averaging fifty or more per hour. And by making his landings so close together he is less likely to forget his errors in between times. Furthermore, the practice work can usually be done in an area not congested by other airplanes or surrounded by obstructions. The landplane practice must be done on an airport where other ships are a constant hazard to the student and he to them.

Normal Take-offs

The best conditions for take-off, and those which the beginner should always have, occur when there is a light breeze and clear water. The breeze should be enough to make slight waves but not enough to produce white-caps. Naturally the plane should not be heavily loaded.

The ship should be taxied into position, the water rudders lifted, and a thorough scrutiny given the intended path of take-off, to make sure that it is clear and that there are no water craft heading across it. The ship is put on the step as directed in Chapter VI, but the throttle is left open. As the speed increases (assuming the stabilizer is set for cruising), the slight back pressure maintained on the control column will keep the nose up, and the ship will fly itself off. And right here is where the average landplane pilot goes wrong. Since he is likely to be in the habit of pulling the landplane off, especially if there is

ample power, he attempts the same thing with the seaplane before proper speed is attained. The result is that the stern of the float is pushed back into the water and the drag is thus increased tremendously; so instead of taking off, the ship slows down. Unless there is considerable excess horsepower, this procedure may result in preventing the ship from getting off at all.

The best angle for take-off is that in which the stern of the float is just clear of the water. A little practice will soon enable one to recognize the feel when the angle is too high and the tail is dragging. Only under one condition is it permissible to exceed the optimum angle and that will be described later. In regard to the "hands off" take-off previously mentioned, this may be accomplished by setting the stabilizer to trim the ship for the optimum angle, which usually is approximately the same as the setting for a steep climb or power-off glide. This type of take-off, however, is of no particular value, except as an indication of how the floats tend to assume the proper trim of their own accord—they are often better than the pilot! It is useful principally in demonstration work.

The experienced landplane pilot may find that on many ships the take-off run may be materially lessened by judicious use of the flaps. Only those which can be operated quickly and which do not depend on a *direct* connection to the intake manifold for their actuation are of service, however. The vacuum-operated type, when no vacuum storage tank is provided, obviously will not function when the throttle is wide open and the manifold pressure is high, such as is the case in taking off. The flaps are of little or no help in getting on the step, and indeed may actually prove detrimental because of the increased drag. But after the ship has attained fair speed on the step, they may be pulled abruptly part way down and, by suddenly increasing the lift, will practically pick the ship out of the water. How far to pull them down and at what air speed, depends on the particular airplane, which should be experimented with until the best combination is determined. After the ship is in the air, time should be allowed for the speed to increase before raising the flaps, and then they should be raised slowly or the plane may drop back into the water. A flap take-off is shown in Figure 52.

Take-Offs with Heavy Load and Calm Water

The take-off condition which requires perhaps more skill than any other, though in no way dangerous (except sometimes to the pilot's feelings), occurs on a hot, sultry day when the air is "dead," the water glassy, and the ship overloaded. If in addition there is little reserve horsepower, the circumstances call for really expert technique. When the throttle is opened, the nose will rise as usual—or possibly the least bit less—and then it may stay there. In other words, the ship may not go on the step.

Figure 52. A Stinson Seaplane Illustrating a Take-Off with Use of Flaps

Of course, any airplane may be loaded so heavily that no one can get it into the air, but if a take-off is possible it may be accomplished by the following procedure.

When the nose has risen as high as it will go with the controls hard back, push it down by abruptly moving the wheel or stick well forward. The nose will drop if the ship has picked up enough speed to be partly on the step, and then if the controls are held ahead, will come back up slightly, or rebound a little. This rebound should be caught by pulling the control column back again, and as soon as the nose has reached its maximum elevation the whole routine should be repeated. After

several repetitions, it will be noticed that the nose goes higher each time and that the speed has increased. If the column is then pushed well ahead and held there, the ship will slowly flatten out on the step, and the controls may carefully be eased back to neutral. It is impossible in a written exposition to give the proper timing for "rocking" the ship onto the step in this manner, and to become expert requires considerable practice. The practice is well worth while, however, as it is extremely humiliating, not to mention poor business, to have to go back to the shore and dump part of the load.

Even after getting on the step, the trouble may not be entirely over, as a few seaplanes and boats can be put on the step with more load than they will take off, unless another trick is used. If after a reasonable run, the ship shows no further increase in speed and does not take off in the normal manner under a slight back pressure on the controls, the stick or wheel should be pulled back abruptly and the plane practically yanked out of the water. Extremely delicate handling is necessary for the next few seconds, as the maneuver constitutes a stall take-off, and if the ship is either leveled out too soon or pulled up too much, it will drop back into the water.

Whenever the water is glassy, the chances of getting off without too much difficulty are improved if there are any small boats moving around, so that the take-off can be made across their wake, provided the ship is not too heavy. Sometimes when all else fails it may be possible to disturb the water enough by taxying in a large circle and taking off across one's own wake.

Swells and Currents

If there is a heavy ground swell several feet high and little or no wind, the take-off should be made *parallel* to the swells, preferably along the crest, but by no means across them, regardless of the wind direction. Striking one of these head on at a little less than flying speed may prove disastrous.

If there is a strong current and *absolutely* no wind, the take-off will be a shade easier if made with the current. However, if there is enough wind to make the ship weathercock, a light current should be neglected and the take-off made into the wind.

Rough Water

It is surprising how rough the water can be without prohibiting a take-off when the ship is in expert hands, but the beginner should stay ashore if there is a chop of more than two feet from trough to crest, and even this is quite rough for a small plane. There is a definite method in choppy water take-offs, which if properly followed, greatly lessens the abuse to which the floats or hull—and the rest of the airplane as well—are likely to be subjected.

To begin with, the throttle should be opened (with controls hard back) as the nose is rising on a wave. In the case of a seaplane this prevents digging the bows of the floats in and keeps some of the spray from the propeller. Similarly, if the ship is a flying boat, there will be less water thrown on the windshield, and hence visibility will be better. It is not likely that any difficulty in going on the step will be experienced unless the ship is overloaded so badly that it is unsafe. The controls should be kept somewhat further back than when in smooth water so as to keep the bow well up.

After planing has begun (but before flying speed has been reached), the ship will begin to bounce from crest to crest of the waves, and each time it bounces the nose will go up. If nothing is done to correct this, each successive wave will be struck with a more severe impact. As the nose goes up, the controls should be pushed ahead in order to prevent the stall, and pulled back again just before striking the next wave. This pulling back at the proper instant is important; otherwise the bows may be pushed under the water. Accurate timing and quick reactions are essential. Fortunately, a take-off under such conditions usually does not take long, for if there is enough wind to make the water rough, there is also enough to get the ship into the air quickly. The worst condition as regards roughness occurs when there is a strong current running against the wind.

For example, if the velocity of the current is ten miles per hour and the wind velocity is fifteen, the water will be as choppy as in a twenty-five mile wind where no current exists, but there is actually only a fifteen-mile wind to help the take-off. Even this situation is probably not as disagreeable as that which arises when because of a tide rip or other causes the water is

very choppy and there is no wind at all. Just how rough the water may be and still be safe to take off from, depends again on the size of the airplane, the wing loading, the horsepower, and, above all, the ability of the pilot. As a very approximate general rule, however, it may be said that if the height of the waves from trough to crest is twenty per cent of the length of the floats, it is much better to fly another day.

Down-Wind and Cross-Wind Take-Offs

There are times when circumstances make it necessary to take off in some direction other than the wind. If the wind is light, the only particular caution to be observed is to allow somewhat more room, especially if taking off with the wind. In general, it is well to keep the nose up a trifle more than in a normal take-off, and to allow the ship to pick up plenty of speed instead of pulling it into the air. As a matter of fact, if there is an off-shore breeze which is not too strong—say under ten miles per hour—the down-wind take-off is considered by many to be safer than taxying out and taking off toward the land, because if there is any motor trouble on the take-off, it is more desirable to have water in front of a seaplane than land. It is definitely not advisable, however, to attempt to take off with the wind if its velocity is in excess of fifteen miles per hour.

Many pilots use the same procedure in the cross-wind take-off as is followed with a landplane; namely, dropping the wing on the windward side, or holding the stick against the wind. In a very strong wind, it may be found that the ship heels over dangerously when the nose comes up prior to going on the step. Under such circumstances it is essential to put the ship on the step headed into the wind and then gradually turn more and more as flying speed is approached. Little if any space is lost by doing it this way, for if the wind is strong enough to turn the ship over, it is also strong enough to put it on the step very quickly. Furthermore, this is the only method possible, since to attempt to make the whole take-off directly across a wind of such velocity will result in a capsized airplane. By using the correct technique a seaplane of average size may be taken off in a cross wind of forty miles per hour without mishap.

Take-Offs in Limited Areas

Sometimes a pilot finds himself in a body of water which does not allow sufficient room for take-off. How he got there is unimportant. Possibly a forced landing, or perhaps the landing was made under one wind condition and the take-off must be made under another. A lake with an open approach from one side and high trees on the other might be responsible for the situation. This is where the step turn is an invaluable asset. The ship is put on the step down wind and then turned into the wind at the down-wind end of the body of water. This permits the actual take-off to be made at the greatest possible distance from the windward shore. However, it should be borne in mind that such a procedure is quite dangerous, and the ship is likely to upset, particularly in a fair breeze, unless very expertly handled. If the ship is loaded so heavily that it will not go on the step down wind, it may be started planing into the wind and a complete circle made. Under this last condition, the pilot who was not extremely foolhardy would leave out part of his load.

Cautions

Another heading for this section might be "When Not To Take Off." One time is when a large boat has just passed and left heavy swells in its wake. It is perfectly possible to crack up by striking one of these. A few minutes of waiting for them to subside or to pass away from the take-off path may avert an accident.

Too much emphasis cannot be laid on the matter of being sure not only that the way *is* clear but that it will *remain* clear until the ship is in the air. Speed boats can come in from the most unexpected angles, and most of their drivers apparently credit airplanes with remarkable qualities, such as being able to stop within a few feet or take off vertically. All water craft seem to assume that they have the right of way over an airplane, whether it is taxying, taking off, landing, or merely sitting still. But whoever has the right of way, the airplane is likely to suffer most from a collision.

And as a final, and what should be an unnecessary caution, but unfortunately is not: if in doubt—about anything—don't take off.

CHAPTER IX

ELEMENTS OF FLIGHT

Practically no one learns to fly today without the services of a flight instructor, though if any beginner were foolish enough to attempt such a thing, his chances would be much better in a seaplane than a landplane. On the other hand, if the student has a thorough knowledge of the operations involved in flying an airplane, the instructor's task may be lightened to some extent and the fledgling pilot may require less dual instruction before he solos.

It is realized that probably a majority of those who read this book are already landplane pilots, and as stated in the preface, it was prepared primarily for such individuals. However, there are many who take their first flight instruction in seaplanes and hence may be interested in knowing how to control the ship in the air as well as how to handle it properly on the water. For the benefit of these beginners it has been considered advisable to include this chapter, which covers only the more simple maneuvers and does not go into the aerodynamic principles of flight or advanced acrobatics. Many excellent books have been written on these subjects, and to them the reader is referred if further study is desired.

Relaxation

This subject is so important that it is considered worth while to devote a special section to it. The most common fault of beginners is tenseness, and until it has been eliminated satisfactory progress is not only difficult but impossible. Unless you "feel" the controls and the movements of the ship you cannot fly correctly, and unless you are relaxed you cannot get this feel. At first you may and probably will find complete relaxation hard to accomplish, but it must be achieved. The first and most important point to watch is the manner in which you hold the

stick. Either let your hand rest—and note that the word is *rest*—on top of the handle or curl your fingers loosely around it. There are three reasons for this. First, the grip on the stick is the point where tenseness will probably begin. By keeping your hold limp and relaxed, a general relaxation is more likely to follow. Second, you can feel more easily the corrections of the instructor, and, third, the instructor will find it much easier to make these corrections.

Bear in mind that any licensed airplane will fly itself and will automatically correct for any air bumps. Hence, do not feel that you must constantly be on the alert to keep the ship from turning over in the air. RELAX—look at the scenery occasionally, shift your position. Even if some unusual bump should put the ship momentarily in an undesirable position, the instructor will take care of any condition that might become dangerous.

After making sure that you are not choking the stick to death, check up on your feet. Your heels should be on the floor and the balls of your feet *resting*, with no more pressure than their own weight, on the rudder pedals. Any normal maneuver in the air may be accomplished without moving the heels from their position—in other words, by use of the ankles alone, with the foot pivoting on the heel as a fulcrum. Don't try to brace yourself between the seat and the rudder pedals. Keep your ankles and knees limp. If your knees shake a little from the nervous excitement of your first time at the controls, let them shake. If you keep relaxed, the tendency will soon pass away. It is common with beginners.

Carry the relaxation on through the rest of your body. You will soon find that you are equipped with a sort of flight indicator in the seat of your pants and that through it you will feel the movements of the ship. If you skid, slip, or otherwise incorrectly handle the controls, you will discover your error in this way. This matter of "feel" is not sufficiently sensitive to eliminate the use of instruments in blind flying, but until it is acquired you will not be able to fly smoothly regardless of how fine the weather may be. In the course of your flight instruction it will be advisable for you to reread this section several times, for unless you can get rid of tenseness in the early stages, you may never become a pilot.

Straight Flight

The next most difficult achievement after relaxation is the ability to fly properly in a straight line. Any vehicle in which you may have ridden besides an airplane could be controlled about only one axis. That is, an automobile, motorboat, or anything else moving on the surface of the land or water may be turned to the right or left (or about its *vertical* axis), and that is all. The airplane may be turned or rotated in the same manner about its vertical axis; it may be nosed up in a climb or nosed down in a dive, thus turning about its *transverse* axis; or it may be tilted sideways (banked), rotating about its *longitudinal* axis. So the new student pilot has three times as many movements to be concerned with as he ever had before. Fortunately, however, the airplane, if properly rigged, will take care of all of them itself.

Before taking off, the instructor will explain the functions of the controls and possibly the position of the nose on the horizon in level flight, though the latter may be deferred until the ship is in the air. The technique of the seaplane take-off is thoroughly discussed in the preceding chapter; therefore it will not be mentioned here, except to caution the novice about climbing too steeply. Your hands and feet should rest lightly on the controls while the instructor is taking off—and, in fact, at all other times when he is flying—so that you can feel his movements. After an altitude of several hundred feet has been attained, the instructor levels the ship out, trims it with the stabilizer for "hands-off" flying, and signals you by some prearranged means—usually shaking the stick, by speaking tube, or, in cabin ships, simply by telling you to take over the controls. Since your hands and feet are on the controls already, your first step is to do exactly nothing. Most students upon the instructor's signal set themselves firmly in the seat, assume a do-or-die expression, brace their feet against the rudder pedals, and clamp a death grip on the stick. Since in this tightening up process they usually unconsciously move some control slightly, the ship immediately begins to wander off its course—which is just what they have been attempting to avoid.

When you take over, you should note the position of the nose with respect to the horizon line, and select some object at which

to steer. This object may be anything—a house, tree, hill, or even a cloud. Remain relaxed and at ease. If the nose should appear to rise with respect to the horizon, apply a slight forward pressure on the stick until the original position is resumed. If the nose goes down, correct with a backward pressure. If the nose swings to the right of the point you have selected, bring it back with a slight pressure on the *left* rudder pedal and vice versa. Glance at the wings tips occasionally, to see that they are the same distance above the horizon line. If the right wing seems lower, apply a slight pressure on the stick toward the left; if the left wing is low, press lightly toward the right. It will be noted that the word "pressure" is used instead of a "movement." This is how the act should be considered, for in any modern ship small corrections require so little movement that it is hardly noticeable. Furthermore, the action of the controls should always be thought of in terms of the effect. Also, if the control system is properly designed and lubricated, the effort required to operate it is slight. This is one reason why musicians and equestrians are usually apt students—they have acquired the necessary delicacy yet sureness of touch and, as for the riders, a good sense of balance as well.

You may wonder, after so many references to the horizon, how one flies on a hazy or cloudy day when no horizon is visible. The horizon is used as a guide only at first. After you have become familiar with flying in general, and a given ship in particular, you will unconsciously stop using the horizon as a guide and will use instead any part of the ground or water you can see. It is only when nothing at all can be seen (as in a fog) that flight instruments become essential.

Ordinarily gentle turns are taken up before the glide, particularly in landplane instruction, since naturally you cannot fly straight indefinitely, and it is just as well not to get too far from the field. However, while we are on the subject of straight flight, the straight glide will be considered also. Drop the nose slightly and gently close the throttle. Some ships become decidedly nose heavy when the power is shut off, necessitating a readjustment of the stabilizer to eliminate holding a backward pressure on the stick. The instructor will probably take care of this if the ship is so equipped, and if no air speed indicator is provided, he will also show you the proper position of the nose

for gliding. If the ship is supplied with an air speed indicator, maintain a speed in the glide of ten to twenty miles per hour above stalling speed, depending on the type of plane. Until you become more familiar with handling the ship in the air, it is important that you drop the nose before closing the throttle, for by following this method there is no likelihood of loss of flying speed. For the same reason, in resuming normal flight from a glide, the throttle should be opened just before leveling out.

Gentle Turns

A turn in which the angle of bank is not more than 30° is considered a gentle turn. Any turn if made correctly requires the use, to some extent, of all three controls. Some instructors neglect to call attention of the student to the fact that even in the gentlest of gentle turns a small amount of up-elevator must be used or the nose of the ship will drop below its proper position. This backward pressure on the stick is extremely slight at low-bank angles, but increases approximately in proportion to the degree of bank, reaching a maximum in a vertical, which will be discussed further in the next section.

To make a gentle turn, apply pressure on rudder and stick simultaneously on the side toward which the turn is to be made. That is, if you wish to make a left turn, press lightly on the left rudder pedal and at the same time press the stick lightly toward the left. Maintain this pressure until the desired degree of bank has been obtained. Then centralize the stick and rudder again and keep the nose from dropping by a slight backward pressure on the stick. To resume straight flight from a left turn, press the right rudder pedal and press the stick toward the right until the wings are level, when all controls should be returned to neutral.

In making a right turn, naturally the use of the ailerons and rudder is the reverse of that just described, but the elevator is handled in the same manner. In a ship with a relatively heavy propeller, slightly more up-elevator may be necessary in a right turn than a left, due to the gyroscopic effect of the propeller and rotating parts of the engine. This effect tends to depress the nose in a right turn and raise it when a left turn is made, when the engine turns clockwise, viewed from the pilot's seat, which is

true of all American types. Foreign engines with counterclockwise rotation act, of course, in just the reverse manner. In any case, in the average airplane the force is so slight as to be practically negligible.

If you are comfortably relaxed, as you should be, you can readily tell by the feel whether your turn is being made properly or not by your seat-of-the-pants flight indicator. If you tend to slide toward the outside of the turn, you are skidding as a result of too much rudder. Remedy: ease off on the rudder or bank more. If you slide toward the inside of the turn, you are slipping. Remedy: more rudder or less bank. These instructions apply to the *gentle* turn however, and not necessarily the steep one.

Steep Turns

Steep turns are those in which the ship is banked more than 45°. Those between 30° and 45° may be considered as medium, and are handled either as gentle or steep depending on the group to which they come nearer. In a steep turn the rudder and elevator change functions insofar as the movement of the ship appears when viewed from the ground. That is to say, the plane is pulled around the turn by means of the elevator, whereas, the position of the nose is determined by the rudder. This may perhaps be more easily understood if the airplane is considered in a vertical bank. Since the rudder is then horizontal it can obviously control the motion of the ship only in a vertical plane. Likewise, the elevator controls the direction of the ship so far as a watcher on the ground is concerned. This interchange of function is often erroneously referred to as "the crossing of the controls." The correct usage of this expression is explained in the section on Sideslips.

The steep turn is begun in exactly the same manner as the gentle turn. As the bank increases, the back pressure on the stick is also increased, and as the forty-five-degree point is passed, the rudder is first neutralized and then applied on the opposite side. In other words, when making a *left* turn at a bank of more than 45°, you should be applying some pressure on the *right* or top rudder pedal. The steeper the bank, the more up-elevator and top rudder are required. After the desired degree of bank has been reached, the ailerons are returned to

neutral. To come out of the turn, press the stick toward the high wing and gradually ease off on the rudder and elevator. A common fault is to leave the stick too far back and come out in a steep climb.

You are not likely to skid in a steep turn, but are much more likely to slip than in a gentle turn. The fault is either that you are using too much top rudder, and thus keeping the nose too high, or that the stick is not back far enough. The remedy in either case is obvious. On the other hand, care should be taken to have ample speed when beginning the turn and not to pull back too much on the stick as either may cause a stall followed by a spin, particularly if accompanied by too little top rudder.

The maneuver, if carefully done, is excellent practice in coördination, especially if the ship is rolled from one turn immediately into another in the opposite direction—the steep figure-eight. However, the practice should be done at an altitude of 1500 ft. or more, and the bank should be steepened by degrees.

Stalls and Spins

Before soloing, you should by all means become familiar with the stall, both with and without spinning. The spin is classed as an acrobatic maneuver, which means, of course, that you must wear a parachute and also come out of the spin above 1500 ft.

To stall the ship, close the throttle smoothly and slowly come back with the stick until it cannot be pulled any further. The movement should be just fast enough to hold the nose in approximately the position of maximum climb. If too rapid, the elevators will take effect while the ship still has excess speed, and the result will be either a whip stall or something approaching it, and the ship will fall off too quickly for the beginner to grasp what is going on. The elevator should come up as the speed decreases, which means that the stick will move farther and farther back as the ship slows down until it finally reaches the limit of its throw. The ailerons are not very effective under this condition, but the rudder takes their place. If the left wing begins to drop, apply right rudder and vice versa. Delicate use of the rudder is required and the dropping wing should be caught before it goes too far; otherwise the ship will wallow down in a

sloppy "falling leaf." Every effort should be made to keep the wings level. If you are successful in this, the ship will either settle in an approximately horizontal attitude or will alternately drop and raise its nose while "mushing" down, depending on the particular airplane.

There is no occasion to be nervous in this maneuver, even though the sloppiness of the controls and the sinking of the ship cause a rather disagreeable sensation. Full control can be immediately regained by allowing the stick to go forward to neutral or slightly ahead of neutral, or by opening the throttle. And remember that the ship cannot spin to the right if the left rudder is applied, nor to the left with right rudder on. If you are slow in correcting the dropping wing and the ship begins to wallow, you had better recover from the stall and try again until you can keep the wings level.

After becoming thoroughly familiar with the stall when the engine is off, you should practice power stalls, leaving the engine running at cruising speed. Greater care should be taken to keep a wing from dropping when the engine is on, as it will vibrate badly if the ship wallows.

The spin is begun exactly as the power-off stall. As soon as the stick is all the way back, apply full rudder on the side toward which it is desired to spin, that is, right rudder to spin to the right and vice versa. Be sure to use full up-elevator and full rudder, as many airplanes will not spin otherwise. Some show a reluctance even with full control, but may be forced in if the throttle is abruptly opened and immediately closed just as the wing drops. Do not make the mistake of confusing a spiral with a spin. The spin has a definite whip which the spiral lacks, and the nose is usually much further down.

Before starting the spin pick out some object in front of the ship as a marker. Keep your eyes on it as long as possible as the ship turns, and pick it up again as soon as possible as you come around the turn. This will enable you to count the turns and will also keep you from getting dizzy. You should make an effort to come out of the spin pointing in a definite, predetermined direction. To recover from a spin, neutralize the controls. Recovery may be somewhat quicker in some ships if opposite rudder is applied, but this should not be necessary in any licensed

airplane. You will come out in a steep dive, from which you should pull out smoothly but not too abruptly. The spin should be practiced until you are entirely at ease, not because spinning is important but because the ability to keep from spinning and to recover quickly is extremely essential.

The Sideslip

One of the most valuable maneuvers is the sideslip, which makes it possible to lose altitude without increasing speed. When landing in restricted quarters, slipping is often essential and should be practiced until it is almost automatic.

A slip is made from a normal glide by dropping one wing and applying opposite rudder or "crossing the controls." The ship continues its forward path at approximately the same speed, but slides off in the direction of the low wing at the same time. The nose may be forced around to one side, thus affording a much better view of the landing area. The rudder follows the aileron both in going into and in coming out of a slip. To be more specific, to put the ship into a left slip, move the stick to the left, thus depressing the left wing. The ship will try to turn to the left, but is prevented from doing so by the application of right rudder. The stick must be held to the left, and the (right) rudder held on during the duration of the slip. To recover, move the stick to the right, leaving the right rudder on until the wings are approximately level. In a right slip the motion is, of course, reversed. Ordinarily a right slip should be made if you are making a right turn, and a left slip for a left turn. Often the slip and turn can be combined by easing off slightly on the top rudder and allowing the nose to swing toward the low wing.

The left slip is ordinarily found more natural as well as more serviceable, since in side-by-side seating the pilot usually sits on the left side and a left slip gives him a much better view and, at the same time, allows him to lean against the side of the cockpit or cabin. In a ship where the pilot sits alone, the throttle is usually on the left side and a right slip tends to throw him away from the throttle. However, regardless of the type of ship, both right and left slips should be practiced, and this practice should be continued throughout your flying career.

The License Test

Many students are so pleased with themselves over soloing that they are not inclined to go through the rather monotonous practice for their license test. Do not let the fun of flying alone keep you from working steadily on the maneuvers required for license. You should obtain a copy of the Air Commerce Regulations, Bulletin No. 7, which will be sent free by the Bureau of Air Commerce upon request. Learn the regulations thoroughly, since you will be required to pass a written examination on them. The requirements for license are also set down in the pamphlet, though your instructor will undoubtedly drill you in the maneuvers necessary. Forget about cross country flights and don't yield to the temptation to go barging off to new places instead of working on your tests. There will be time enough for that after you have acquired your license.

You may have noticed that no mention of landings has been made in this chapter. These were purposely omitted, as the subject is of sufficient importance, not only to the student but to the finished landplane pilot, to warrant a chapter of its own.

CHAPTER X

LANDING

The experienced landplane pilot may find some of the instructions given in this chapter rather elementary, since the seaplane student who is just learning to set the ship down is considered, as well as those who have already become expert on the airport. However, there are many conditions under which the seaplane landing differs from that made with wheels, and without the proper knowledge and technique even the most capable land pilot may find himself in difficulties.

DETERMINING WIND DIRECTION

The airport always has some sort of wind indicator specifically intended for the purpose. Except at large bases the seaplane pilot is not usually provided with this convenience and must depend on other means for determining wind direction.

If there is no current, any boats which may be at anchor provide an excellent indicator as they will point into the wind. When landing in strange water, however, where it is not known whether a current exists, some additional check is needed. Flags, smoke, the direction in which seagulls or other water fowl are landing and taking off, the set of sails on sailboats—all are good aids. As regards the last of these, Figure 53 is intended as a guide for those who are not familiar with sailing.

If there is enough wind to affect the landing appreciably, its *line*, though not necessarily the direction in which it is blowing, may be determined accurately by streaks on the water. These streaks are difficult to describe but are easily recognized once they have been seen. They always lie exactly in the line of the wind and appear as a faint change in the color of the water. If there is nothing else visible to indicate from which quarter the wind is coming, the ship may be flown close to the water, as slow as possible, and the drift noted. The landing should

then be made in a direction opposite to the drift and in line with the streaks.

When the wind is strong enough to cause whitecaps, both the path and the direction may be determined from the water alone. The streaks become much more evident, often taking on the appearance of fine white lines. The foam or spray from the waves *apparently* moves *into* or *against* the wind. Actually, of course, it does not; but the wave rolls with the wind and passes from under the crest, and since the white foam is more visible, it has the appearance of moving in the opposite direction. This does not apply in the case of breakers on a beach. The crests

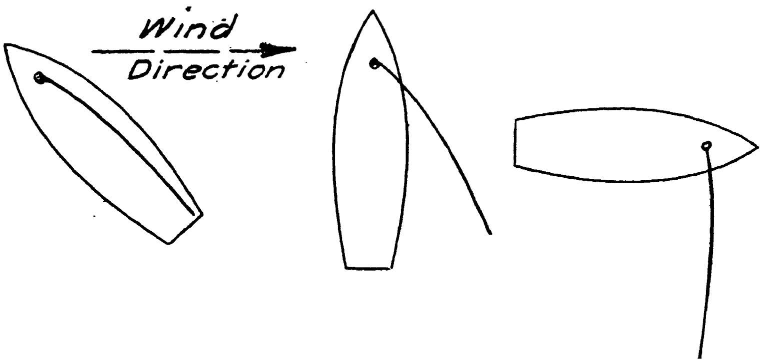


FIGURE 53. DETERMINING APPROXIMATE WIND DIRECTION FROM SETTING OF SAILS ON BOATS

of these move toward the shore regardless of wind direction. They are more violent, as a rule, if the wind is on-shore, but as a wind direction indicator they are worthless. Away from the shore however, the whitecaps and streaks are an infallible and highly accurate guide.

LANDING IN NORMAL WATER

By normal water is meant water which is neither glassily calm, nor unduly rough, nor full of heavy swells—in other words, water conditions such as would be encountered in a bay or small lake when the wind velocity is between three and fifteen m.p.h. The expression "landings in normal water" is used rather than "normal landings" because, as pointed out before, while a per-

fect landing may be made with a landplane in one position only, a fairly wide range of attitudes is permissible with the seaplane.

The student should begin with a slow or full-stall landing, both for the development of judgment of his height above the water and for possible future landplane flying. This corresponds to the three-point landing on wheels, and the landplane pilot should have no trouble making it without practice, bearing in mind, however, that the floats of a seaplane, as a rule, hang lower than the wheels, and if he is flying a boat, that the bottom of the hull is ordinarily not as far down as wheels. Naturally, he should familiarize himself with his height above the water when the ship is at rest before he ever takes off.

In any landing the ship is brought down in a glide to a height of fifteen or twenty feet and gradually leveled out, so that by the time the floats are about a foot or two from the water the nose has come up to or slightly above its normal cruising position. It is quite important that the glide be kept as slow as possible and yet maintain a safe margin above stalling speed. A safe margin is simply to provide adequate control, so that no "mushiness" or settling is felt. Too fast a glide means that the ship will take a long time to land after it is leveled out, with the result that the green pilot is likely to become impatient and force it down too soon, and thus surely make a poor landing. Paradoxical as it may sound, no airplane can be "landed." It must land itself. After leveling out, the ship should be *kept in the air,* a foot or so above the water (as previously described), *as long as possible* and should not be allowed to gain or lose altitude. This may be done only by coming back slowly with the stick and raising the nose (or dropping the tail) proportionately with the decrease in speed until finally the stick is all the way back, the ship is in a full stall, and the sterns of the floats touch the water at the slowest possible speed.

This type of landing is not the prettiest in a seaplane, as the ship rocks forward onto the step, sometimes with more or less of a splash. But it is the safest for all around use.

Many beginners make the mistake of looking at the water immediately beneath them to determine their height. It is impossible to locate the water in this manner. The point of vision should be from one hundred to three hundred feet ahead and the eye should glance back and forth within this distance. But

never nearer than a hundred feet or so. It is perfectly possible to land entirely from the horizon. However, it is not recommended as a habit because frequently there is no horizon visible.

The smoothest landing and the style which should be learned next is that in which the stern and the step touch the water at the same time, or the first and second steps if there should be two. (See Figure 54.) The approach and leveling out are the same as in the stall landing, but the ship is allowed to touch

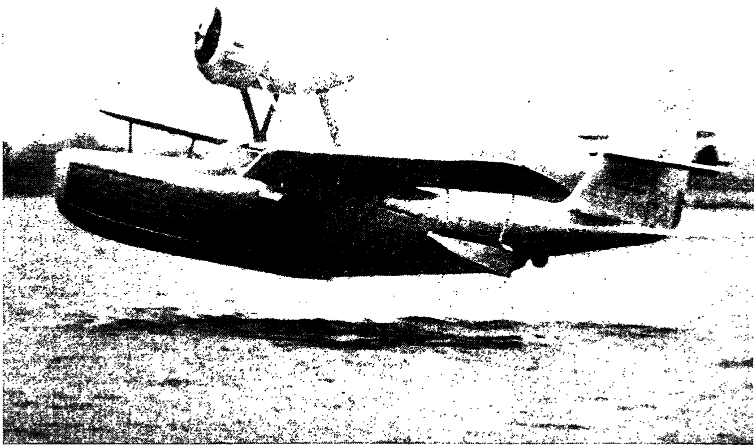


FIGURE 54. FLEETWINGS "SEABIRD" LANDING IN CORRECT POSITION

somewhat sooner. However, *the stick must be moving back at the instant of contact* in any landing except the full stall. If the ship is put in any sort of landing position and held there, it will drop out from whatever altitude it may have and fall into the water with more or less of a smack.

On water that is fairly smooth but *not glassy* a level landing is permissible. This is also known as a high speed, "hot," or step landing. The step of the float is allowed to touch while the nose of the ship is only slightly above the cruising position. Care must be taken that the stick is moving back, however, and also that the nose is not below the cruising position, as otherwise a bad bounce or ricochet is likely to occur. In this case the student should open the throttle, level out, and try again.

All landings should be made with *one hand on the throttle* so there will be no fumbling for it in case of emergency. If the ship is to be taxied any appreciable distance after landing—and the beginner should land far enough from shore so that some taxying is required—the throttle may be partially opened just before coming off the step and the remainder of the distance covered by running on the step, assuming, of course, that no sharp turns are necessary.

Also, although seaplanes usually have plenty of space for landing, the beginner should keep the throttle closed during the glide, except for clearing the engine occasionally. If he becomes accustomed to using the engine to stretch his glide, he will never become properly familiar with his gliding range and, in the case of a forced landing, may find himself in difficulties.

The Power-Stall Landing

This type of landing is used to some extent in landplane work but is required much more often with seaplanes. If a ship is held at the landing angle with wide-open throttle, it will climb. If the r.p.m. are reduced the proper amount (somewhat below cruising speed), it will maintain a given altitude. If the r.p.m. are still further reduced the ship will, of course, settle. The power-stall landing consists of putting the ship in the proper attitude for a landing at some distance above the water and maintaining, by the use of the engine, just enough speed to allow a gradual sinking. The ship may be brought down several hundred feet in this manner if the need arises, though it is hard to imagine circumstances which would require more than fifty to a hundred feet. It is somewhat difficult to regulate the engine speed so as to allow exactly the desired rate of descent; so most pilots close the throttle fairly well, opening it partly at intervals of a few seconds to maintain the necessary airspeed. Care must be taken not to let the speed get too low, as the usual consequences of a stall will result. This type of landing should be practiced under normal water conditions until the student becomes expert in its use, so that when the need for it arises there will be no lack of confidence.

Landing in Rough Water

Landings may be made in water much too rough for a take-off if the power-stall is used, preferably with the ship in the full-stall landing position. The approach and leveling out are the same as under normal conditions but before the sterns touch, the throttle should be partly opened. The tail of the floats should be dragged through the water and the ship practically lowered by careful use of the engine. Of course, if the throttle is closed abruptly, the ship will settle into the water immediately. It is often the case that the spaces or intervals between the waves vary. By holding the ship off until a larger space is encountered, it is frequently possible to land in very rough water without much abuse to the airplane. Also, by keeping the engine partly on (in the manner described) it is possible to pick the ship clear quickly, by giving full gun in case an unusually large wave or swell is encountered.

Landing in Glassy Water

Glassy water, without the faintest ripple, especially if accompanied by a fog or haze which obscures the shore line or horizon, produces the most dangerous condition that the seaplane pilot is likely to encounter, because even the most experienced cannot tell the location of the water within ten or sometimes even fifty feet.

If the shore is visible, the landing should be made as close to it as possible, and by looking at the shore not at the water. If it is not practicable to land near shore, pick out any object visible in or on the water, such as a boat, or buoy, or floating log. Some pilots recommend throwing something overboard which will float or at least make enough ripples to mark the surface, then circling and landing near the object. This device seems hardly necessary, however, if the ship is reasonably maneuverable, for if there is no object visible in or on the water, the power-stall landing is resorted to, allowing at least fifty feet for misjudgment. (The chief danger from glassy or "slick" water is to the pilot who is inexperienced in water flying, as he thinks he knows where the water is but actually doesn't. Once he has learned that he can't determine its exact location and has

become familiar with the proper steps to take, the hazard is greatly lessened.)

Night Landings

A landing at night is very similar to one in slick water in daylight. Lights on the shore or on boats lessen the difficulty materially, but if none are available, the same valuable power-stall must be used. The area where the landing is to be made should first be flown over or "dragged" and scrutinized as thoroughly as possible. Boats or other obstructions can often be distinguished even though it is quite dark, and obstacles such as these present the major hazard in night landings. Landing lights are worse than useless, as they cause a blur through which it is impossible to see and do not aid at all in finding the water. A powerful light under the fuselage, located on the side away from the pilot so that he cannot see the glare, is helpful in showing up any object which may be directly in front and is of great service in taxying. This is referred to in Chapter III. The water light mentioned in the same chapter will also be helpful in locating the surface. However, if there is no likelihood of encountering obstructions and the altimeter is accurate and properly set, the ship may be power-stalled down from a hundred feet and landed without undue hazard.

If the moon is fairly bright, no other help is needed, provided that the landing can be made so that the moonlight comes from in front or from one side. If it comes from behind, it is of little help unless extremely bright. However, in either case, obstructions are more likely to be visible than when there is no moon, so the pilot's mind is to that extent relieved.

Cross-Wind Landings

Just as it is sometimes necessary to take off in some direction other than into the wind, there are also occasions when, due to restricted quarters or some other reason, it is desirable or essential to make a cross-wind landing. As for landing directly down wind, the only time it could conceivably be required would be in case of engine failure following a take-off over land; otherwise if there is room enough to land down wind, there should certainly be more than enough to make the landing into the wind

in the normal manner. Furthermore, there is no especial technique involved other than to bring the ship in as slow as possible, and for this reason no additional instructions concerning it are considered necessary.

To make a good landing across the wind does, however, require skill and practice, and the former is attained by the latter. Needless to say, the practice should begin when the wind velocity is low. When traveling across the wind, the ship, of course, is drifting, so that it is not moving in the direction the nose is pointed. This means that in a landing it will strike the water going sideways with a speed equal to the wind velocity, unless steps are taken to avoid it. There are two methods of offsetting the drift. One is to come in the last few feet with the windward wing lower than the other. This, in effect, constitutes a slight sideslip into the wind. In using this method with a flying boat, care should be taken that the wing is not dropped low enough to cause the wing-tip float to strike the water, both because of abuse to the float and because immersing it tends to make the ship swing into the wind much too abruptly for safety.

The other method ordinarily used (and greatly preferred by the author) consists of holding the wings level and skidding to windward by use of rudder on the lee or down-wind side. This tends to eliminate the drift and at the same time point the ship in the direction it is actually moving. It is well to come in with a little extra speed, both because there is more time after the ship is leveled out to judge the drift, and also because a higher speed at the time of contact lessens the amount of drift proportionately. The rudder should be applied just before contact with the water is made, so that the plane will not have time to actually begin to make a normal turn. It will also be found necessary in most ships to hold on a little opposite aileron—that is, the stick should be held toward the windward side. After the landing is made, the situation may still be somewhat ticklish, especially if the wind is strong. As soon as the ship slows down it will endeavor to weathercock, and unless additional rudder on the down-wind side is used it may swing so quickly that it will capsize. This possibility has been discussed in Chapter VI, and the forces involved are illustrated in Figure 41.

As in the case of all other maneuvers, this one should be practiced faithfully, preferably at first with the instructor, and

in light winds at angles of 45° or less until the necessary judgment is acquired. The average seaplane or flying boat, if expertly handled, should be able to get away with a cross-wind landing with a wind velocity of twenty-five to thirty m.p.h. More wind than this is likely to make it extremely hazardous, not only because of the increased drift but particularly because of the height of the waves, which in the case of a twin-float ship may allow the down-wind side to drop, lifting the other wing and permitting the wind to get under it, a condition which should be avoided as explained previously.

Swells

There are two kinds of swells—the long, slow ground swell, which usually occurs more commonly in calm water, and the swell thrown up by a boat. Neither ever looks as bad from the air as it actually is, and the ground swell in calm water is exceptionally hard to see.

In a heavy ground swell the landing, just as the take-off, should be made parallel to the swells and preferably along the crest. In the case of swells caused by a boat, either a spot should be picked not so disturbed or the landing not made until the swells have subsided.

Emergency Landings

Many people, even landplane pilots, seem to think that it is an exhibition of foolhardiness or worse to take a seaplane across country away from the water. While it is true that staying over water takes all the danger out of forced landings and, hence, from the standpoint of safety it is highly desirable to keep water within gliding distance, nevertheless there is little, if any more risk in traveling over land with a seaplane than a landplane. In swampy country, high grass, corn fields, and the like, the seaplane has much more chance of getting away with a landing without turning over. In trees or rocks there is not much difference between the two, except that the floats will probably absorb more of the initial shock than wheels, and thus lessen the damage to the rest of the ship. Of course, on a smooth field the landplane has the advantage of being able to take off again

when repairs have been made, provided the field is big enough. The seaplane can be landed safely but naturally it must be disassembled and taken to the water, or the floats must be removed and the wheel landing gear put on before it can be flown.

The advice to the seaplane pilot is to stay within reach of the water. However, if a forced landing occurs when no water is available, the procedure varies with the terrain. The consensus of opinion, among those who have tried it, is when making a landing on a smooth, hard field, one should come in with

FIGURE 55. "A DUCK OUT OF WATER"

Bellanca seaplane after forced landing on land. Pilot, H. P. Ayres of Canada.

the keels parallel to the ground, directly into the wind, and naturally as gently as possible. Figure 55 shows a seaplane which was landed in this manner when the engine went dead, and which was dragged back to the water and flown away without disassembly or repairs to floats or structure.

On swampy land, high grass or corn, trees, or rough ground—in fact, any kind of surface except a field similar to that illustrated—the full-stall landing is recommended. One famous air mail pilot of the earlier days had a saying which is usually, if not always, true: "If your nose is up when you hit, you can walk away from it." There may be some room for doubt as to the accuracy of this statement if the object encountered happens to be, for instance, the vertical side of a cliff, but in prac-

tically any other situation it is probably approximately correct. In any event, the stall position is the correct one for any kind of crash landing.

A forced landing out of sight of land, especially if it is away from shipping lanes and the wind is off-shore, may be a serious predicament. A sea anchor of some sort should be rigged at once to hold the nose into the wind, and someone should be posted on the center section to watch for boats. Every pilot should have a definite understanding with his base, some member of his family or other reliable party, to the effect that if he does not wire or report by a certain time, he is in distress. The Coast Guard can then be notified and a search instituted. A Very's signaling pistol will be a source of great comfort to the occupants of the ship if they are adrift after dark. There is no use in wasting the ammunition, however, until the lights of some vessel can be seen from the top wing. Aimlessly shooting it away is likely to mean that if a boat is sighted there will be no means of attracting its attention. If no Very's pistol is on board and any pole or rod, such as the boat hook and paddle combination previously described, is available, a torch can be made by tying a rag or handkerchief around one end, dipping it in the gas tank and, after getting out on the bow of the float or the engine cowl (to avoid the possibility of fire), lighting it. This will be visible for several miles, but is by no means so satisfactory as the red signal flares from the pistol.

The Badly Damaged Seaplane

While this subject may not be strictly classified with landings, it is either in landing or taking off that damage usually occurs. Many ships have suffered relatively minor damage on the water, and then have been sunk and ruined beyond repair because of ignorance on the part of the pilot, the salvage crew, or both.

The procedure varies, of course, with the locality. For example, if a hole were punched in a float while taxying into a regular base, the thing to do would be to get on the step and make the base as quickly as possible; whereas, if the same thing occurred in some out-of-the-way spot, the proper procedure (if sufficient fuel were on board) would be to take off immediately

and fly to the nearest repair station. This is assuming that the damage is beyond emergency repair. (See Chapter XII.)

If the damage occurs under conditions which prohibit taking off or going on the step immediately (for example, a collision with a boat), and the plane is in danger of sinking, remember that one float will usually support the entire weight of the ship. All available occupants should be sent out on the wing on the side of the good float so as to take the weight off the damaged one. This will often make it possible to taxi the ship to shore.

If any small boats are available, it is often possible to support the damaged side on one of these and either taxi or tow the plane in. Speed in getting the damaged float held up is, of course, highly important but should not take precedence over care in doing a secure job. In other words, "Make haste slowly."

Sometimes a ship is turned over—either through accident or poor flying—without injury, except immersion, to the floats or any other part of the airplane. And yet by the time it is salvaged, it is beyond repair. If the floats are in good shape the ship will not sink for some time—several hours or even several days, depending on how tight the bottoms are. Accordingly, there is often plenty of time to secure a floating crane which can pick the ship up by lines passed around the floats, preferably at the strut attachments. It may then be disassembled while hanging upside down and beyond recovering and thorough cleaning and inspection, need no further repairs. The engine should be taken apart as quickly as possible, of course, and the whole ship washed with fresh water without delay.

If no crane is available, it is sometimes possible to make the ship assume an approximately vertical position by removing the hand-hole covers on the two forward water tight compartments and allowing them to fill up. Then by fastening one motorboat to the bow cleats and another to the tail and letting them pull in opposite directions, with a certain amount of luck the ship may be turned right side up. It is even possible to take off the wings and tail surfaces under the water, in which case the fuselage can probably be brought ashore without serious damage.

Unless the utmost thought and care are given to the problem, however, all the unfortunate owner will have when the show is over is a pair of floats and nothing else.

Chapter XI

SECURING AND HANDLING

If a ship is properly tied down it will go through a real gale without damage, but to leave it sitting on the ramp or beach, or lying at anchor without taking the proper precautions is simply inviting trouble. The methods given below of securing the ship under various circumstances are the result of experience, and if followed they will save serious repair bills.

Tying Down on Ramp

The ship should be turned tail into the wind if possible. In any case, the stick or wheel should be tied full ahead and in the center, so that the elevators will be held down and the ailerons in neutral. The rudder pedals should be tied in neutral. This procedure in tying should be followed regardless of whether the ship is to be secured on ramp, beach, dock, or mooring. The purpose in tying the elevators down is that if the wind comes from the nose, as may happen during the time the ship is left on a ramp (and will certainly happen when a mooring is used), there is less tendency for the ship to lift off. The reason for turning the tail when possible into the wind is the same; there is no tendency to pick the ship up when the wind strikes it from the rear. Unless the ailerons and rudder are securely fastened they will "slat" back and forth, from one extreme to the other, with great likelihood of damaging some part of the control system.

Most ramps are provided with ring bolts to which the tie-down ropes can be fastened. If there are none available, the ropes should be passed around the planks. The aim in tying down is to get the ship so blocked and fastened that even the slightest rocking is prevented, for any slight movement if continued through the night may work the fastenings loose.

If the ship is a twin-float seaplane, blocks should be put under bulkheads near the stern of the floats and wedged tight. If it is

a flying boat or single-float seaplane, the same thing should be done and, in addition, blocking should be put under the wing-tip floats. Lines should then be run from the bow, the stern, and each wing tip to the ramp. Many ships are provided with tie-down rings, through which the lines can be passed, near the ends of the wings. Otherwise, it will be necessary to fasten the lines to the outer wing struts, and care should be taken that the fastening is made in such a way that no damage will be done when it is pulled tight. It is impossible to pull a single line taut enough to eliminate all slack. Hence, the tie-down rope should be double in the form of an inverted "V." In other words, the line should be fastened to the ramp, carried up to the ship, and then back to the ramp several feet away from the first point of fastening. It should be pulled as tight as possible and tied. Then the two sides of the "V" should be drawn together with the rest of the line in the manner shown in Figure 56. If the work is conscientiously done and the ship is fastened in this manner at bow, stern, and each wing tip, the owner can go to bed and rest assured that in the morning he will find the ship as he left it.

If the ship must be left on a beach, the same procedure is followed as when a ramp is used, except that in place of the ring bolts, stakes driven well into the ground and at a good angle to the line of pull must be used. It is also advisable to block up the rear of the floats until the ship is in a slightly nose-down position to eliminate lift on the wings in case of wind. The ship should either be dragged or taxied on planks above high-water mark before attempting to fasten it down. If a real blow is expected, it may be desirable to fill the floats with water, as stakes driven into sand are not likely to hold too well. This means a weary job of siphoning and pumping out when the ship is to be launched again, but it also may mean saving the ship from being completely wrecked.

Tying to Dock or Pier

If there is any rise and fall of tide, a ship cannot be satisfactorily tied up to a single dock or pier for any length of time. For temporary fastening, the bows of each float may be pulled in close to the pier and tied so that the ship cannot swing far enough to strike the wings against the pier. If the plane is a

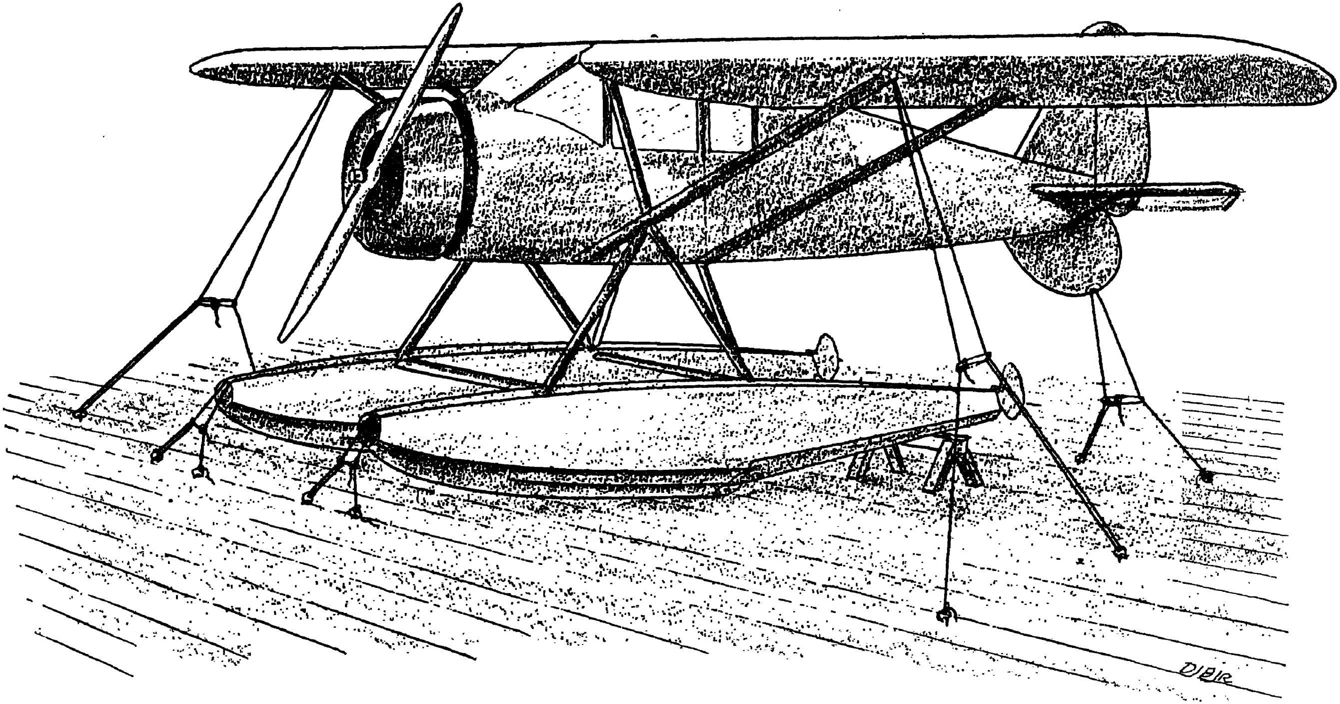


FIGURE 56. PROPER METHOD OF TYING DOWN A SEAPLANE

flying boat, lines may be run from each wing tip and the bow pulled against the pier.

Two adjacent parallel piers make an ideal arrangement, however, if the distance between them is from twenty to forty feet more than the span or the length of the airplane. In such a situation, either of two methods is equally satisfactory. The ship may be fastened with its longitudinal axis, or center line of the fuselage parallel to the piers. In such a case a line is carried from each wing tip to the pier on that side, or from each mooring cleat in the same manner. If the mooring cleats are used, another line should be run from the tail to each pier. Care should be taken to leave enough slack in the lines to allow for the rise and fall of the tide. Another method is to fasten the ship so that the span is parallel to the piers. In this case, all that is necessary is one line from the bow and one from the tail, again taking care that slack is left for the tide. This latter method is usually somewhat easier than the first. The ship is well-sheltered on three sides in either case and little concern need be felt when leaving it in such a location.

Tying to Raft

If a raft is well-secured and thoroughly padded to prevent chafing, it makes an excellent location for overnight storage in any ordinary weather. The ship is simply brought alongside, preferably to the lee of the raft, though if the padding is good this is of secondary importance. The float which is against the raft is well-fastened at bow and stern. In the case of a flying boat, the raft is not so satisfactory as one wing-tip float must be brought up onto the raft and very securely fastened; otherwise chafing will occur between the raft and the tip float. Some sort of padding should be put under the float to eliminate as much of this as possible and the hull should be fastened thoroughly so as to eliminate as much as possible any movement between it and the raft.

Mooring

It is extremely inadvisable to leave a ship at *anchor* overnight, as a good wind may cause the anchor to drag and pile the ship up on the beach, or wreck it against a boat, or blow it out

to sea. A yacht mooring, consisting of a hundred pound mushroom anchor or equivalent, however, will hold an airplane of average size in almost any kind of a blow, and usually affords better protection than if the ship is tied on the beach. It is highly important, of course, that there be no leaks in the floats if the plane is to be left in the water overnight or even for several hours. Fastening the controls as described in the beginning of this chapter is more important when the ship is left at a mooring than at any other time.

If the ship is a flying boat, a single line attached to the mooring ring in the bow is all that is ordinarily needed. In the case of a seaplane, a bridle such as that described in Chapter III must be used or something similar rigged up. In any normal wind the mooring cleats on the bow are amply strong, but if any uneasiness is felt, the bridle may be passed around the mooring cleats and carried back to the front spreader bar, close to the floats. The line which runs from the point of the bridle to the mooring should be at least ten or fifteen feet long, for the longer the line the less the shock of the waves will act on the fastenings. A mooring such as described is perfectly safe for the average airplane in winds of a velocity equivalent to five m.p.h. above the stalling speed of the ship. In case of higher velocities it may be necessary for someone to stay on board and perhaps keep the engine running and operate the controls to prevent the ship from bouncing out of the water.

Handling on Shore

By this is meant handling on ramps or in hangars. The subject has been covered to some extent in Chapters III and VII, but it is believed that some additional information will be helpful. The fact that floats and hulls will withstand severe abuse without apparent damage leads many operators to subject them to punishment, which is both unnecessary and extremely ill-advised. So long as the weight is supported vertically and evenly along the length of both keels, and each is carrying half the load, the ship may be moved *in a straight line* under its own power or by a tractor without danger of damage other than a certain amount of wear on the keel strips. If the sliding is done on smooth, wet wood, even this wear is negligible. But dragging the ship over

uneven surfaces so that most of the weight is temporarily thrown on one spot on one float is very likely to cause damage, which though it may not be immediately evident will produce leaks and possibly more serious troubles, such as a buckled keelson or damaged bulkhead. Turning the ship around without suitable beaching gear is particularly conducive to sprung seams and other injuries, due to the twisting strains imposed on the float structure. If no beaching gear is available, the ship should either be sailed backward onto the ramp or brought in head on and then turned around in the water and dragged up backwards with a winch or tractor. In this case the drag rope should be attached to the *front* spreader bar, as close to each float as possible, thence *under* the rear spreader bar to the winch.

Another bad practice sometimes followed, often by mechanics who should know better, consists of using a short axle and one wheel on each float, instead of two wheels for each, or a substantial through axle such as that illustrated in Figure 27. This sort of mishandling causes bent spreader bars and possibly strained attachment fittings, and it may also damage the bulkheads to which the spreader bars are fastened.

When skid boards are used, the ship may be turned if a turning radius of fifty feet or so is used. Skid boards are recommended only as an emergency measure, however, except in the case of very light ships or those which are not provided with an axle tube.

If the same beaching gear is used for a number of ships, whenever one is removed from the gear it should be left blocked up so that the gear may be reattached without difficulty. Blocking should not be concentrated and preferably should extend over at least two bulkheads. Boxes or trestles of some sort should be put under the rear portion of the floats to prevent tipping in case a careless mechanic or visitor steps on the after deck.

If the ship is to be left for any appreciable period of time, the hand hole covers should be removed to allow circulation of air.

Chapter XII

INSPECTION, MAINTENANCE, AND REPAIR

Inspection

The Department of Commerce requires that any airplane be inspected at maximum intervals of twenty-five hours, and any experienced operator knows that such inspection is well worth while from the standpoint of peace of mind as well as the finding of minor wear and damages which, caught before they become serious, save expensive repairs later. In addition to the regular airplane inspection in some respects the seaplane requires particular attention.

Floats should be inspected daily for leaks and damage, as it is quite possible to strike a small floating object when landing in choppy water without feeling it at all. If no appreciable quantity of water is found in any of the compartments, it is a good sign that there are no leaks. By appreciable quantity is meant a cupful or two after the ship has been in the water for a day or night. If more water is found, the compartment in question should be partially filled with water and the leak located and repaired.

The bottoms, particularly the portion forward of the step, should be examined for dents and, if any unusually hard landings have been made, for deformed bulkheads. A deformity of this nature may be detected by laying a straightedge along the part in question and noting how much depression exists. The bulkheads should also be examined on the inside with a flashlight if any damage is suspected, but the corrugations pressed into some bulkheads for stiffening purposes should not be confused with buckles.

The tips of metal propellers should be inspected for pitting due to spray and should be rubbed smooth with fine emery cloth and polished with an oilstone as soon as any roughness appears.

If the pitting is not taken care of at frequent intervals, it will soon become so bad that the propeller will have to be sent to a service station for rebalancing.

Control wires, especially where they pass over pulleys, should be examined for rust and broken strands and control surface hinges should also receive frequent attention.

At least once a year, unless the ship has been especially prepared for seaplane use as outlined in Chapter V, the fabric should be opened along the tail post and lower rear longerons. If serious corrosion appears, it may be necessary to strip the whole covering and corrosion-proof the fuselage as previously described. The inside of the longerons may be inspected by cutting a small "V" from the tubing, and later welding a patch over it. The inside of tubes which have not been oiled and sealed should receive attention, and the fabric should be opened along any metal trailing edges, particularly on lower wings. The lower fin should also be opened unless it has been metallized or otherwise thoroughly protected. The inside of any dural or aluminum structures is especially vulnerable to corrosion, which shows up as a whitish flaky deposit.

Maintenance

Ships operated in salt water should be washed thoroughly with fresh water from a hose every day they are used, both to lessen corrosion and to remove the dried salt which spoils the appearance and ultimately attacks the finish. The hose should be directed from the front, and, of course, should be kept away from the hot motor. The propeller, especially at the tips, should be kept oiled with engine oil, and the engine, unless metallized, should be sprayed with kerosene at frequent intervals.

Control hinges should be oiled frequently and control wires kept covered with one of the greases mentioned in Chapter V. Engine controls of the Bowden wire type (or any others which consist of rods or wires running through tubes) should have daily applications of penetrating oil at their upper ends.

Rivets on the floats should be examined for corrosion, which appears as white spots protruding *through* the paint. Salt deposits and young barnacles have a similar appearance but will wipe off leaving the paint intact. Corroded spots should be

cleaned carefully with steel wool, so as not to remove the coating of chemically pure aluminum which protects the dural underneath and the area repainted. Any scratches on bottom or sides should also be cleaned and painted.

Any rust which appears on steel parts should be cleaned off with fine emery cloth, and the spots primed and painted. Zinc chromate primer is valuable for this type of work because it dries quickly and at the same time affords good protection. The aluminized Bakelite varnish described in Chapter V is recommended for the inside of floats and for any other point where the color is satisfactory.

Careful maintenance will pay high returns in avoiding expensive repairs.

Repairs

Minor leaks or holes in floats may be temporarily repaired by doping on any kind of fabric, applying a number of coats of dope. Such a patch will not last long, however, and if possible a piece of metal should be put over the hole and fastened with machine screws. Between the metal and the float or hull a piece of fabric thoroughly coated with Goodrich Plastikon No. 169 (or some similar filler) should be laid. This makes an excellent emergency repair which will last until the machine screws rust out. Plastikon may also be used for stopping small leaks between bulkheads or in other seams. Other materials which are made for the same purpose are Bakelite Seam Compound and Dolphinite. Permanent repairs on alclad floats or hulls should be made in accordance with the instructions given below.*

"**Painting.** To properly refinish a float the old paint should first be removed, and for this purpose a good grade of commercial paint remover is recommended. Any corroded spots should then be lightly wire-brushed until the discolored material is bright again. The float should next be washed with a cleaning solution such as Valentine's No. 1044 Solvent or Piece and Stevens Cleaner, and then with vinegar, followed by fresh water. It is important not to allow the cleaning solution to soak into the seams, since it would dissolve the seam compound and might tend to cause leaks. Care also should be taken not to touch

* *Edo Service Manual.* Edo Aircraft Corporation, College Point, Long Island.

them with greasy hands after cleaning because it would interfere with proper adhesion of the primer. One thin coat of Zinc Chromate Primer (such as Berry Brothers P-27) is then sprayed on. It should be followed by two spray coats of pigmented lacquer.

"In preparing the lacquer, it is suggested that two pounds of extra fine aluminum powder be thoroughly mixed into two quarts of lacquer thinner. After stirring thoroughly, add to the mixture one gallon of exterior clear lacquer (such as Berry Brothers Berryloid No. 507). With this method the flakes of aluminum powder form a protecting scale which prevent water from penetrating. Where this plan cannot be followed, a good grade of salt water resisting paint, enamel, or pigmented varnish may be used.

"Water Test—Inspection for Leaks. Water tests should be made after every overhaul as well as for the general detection of leaks, and the ship must be hauled out for the purpose. Before filling with water, however, it is absolutely essential to properly brace the floats, since they may otherwise be severely strained by the weight of the water and leaks, not occurring in normal use, may appear. Properly fitted forms, located under bulkheads and spaced about four feet apart with additional supports for the keel in between, are suggested as the best arrangement. If this is impractical, see that the keel forward of the step is flat on the floor, get several supports under the keel at the bow and stern, and block up at a number of points along the chine as well.

"To test the floats, fill alternate compartments with water and after noting any leaks between bulkheads, fill all compartments and inspect for leaks outside. Unless the floats are very well braced it is advisable, however, only to fill part of the compartments at any one time. All compartments should be filled to the top. Leaks are best marked with an indelible pencil. The water can be siphoned out with a hose.

GENERAL REPAIRS

"Riveted aluminum alloy structures of the type used in Edo floats are extremely simple to maintain and repair, and by reading these instructions and examining the fastenings in the floats, a mechanic and helper should learn in a few hours' time how to

take out and put in rivets for a minor patch. Practice can be obtained to advantage, moreover, on scrap pieces of metal before starting on the actual float.

"**Equipment.** The tools required are some drills, tin shears, a hack saw, file, hammer, wooden mallet, small cold chisel, rivet set, and a bucking bar. A rivet set is a punch with a concave end of the size which one wishes for the head of the rivet. The bucking bar is an iron or steel bar weighing from one to five pounds which is pushed up against the head of the rivet, and, as a rule, the heavier the bucking bar the better the job. The part of the bar pressing against the rivet can be either smooth or slightly roughened in order to get a better grip on the rivet.

"The material required is a piece of alclad sheet, some rivets, Parker Kalon bind head screws, and machine screws (cadmium plated, if possible), as well as some cotton cloth and seam tape, Dolphinite and Bakelite Seam Compound—all of which are supplied in the standard Edo repair kit. The proper rivet to use is A17 ST as supplied by the Aluminum Company of America or Edo. They do not require heat-treating. Ordinary 17 ST duralumin rivets can be headed cold without heat-treatment, in an emergency, but they are harder to rivet and if overworked will become brittle and crack. It is very important not to use any brass or copper rivets or screws, as these will cause very rapid corrosion of the alclad.

"**Taking Out Rivets.** Rivets can be removed by knocking their heads off by a side blow with a small cold chisel. A single smart blow with a hammer will knock the head off, whereas a series of gentle blows will tend to tear the sheet. As a wide cold chisel cuts into the sheet, it is best to grind down a center punch or rivet set, so that the end is at a slight angle and has a flat elliptical face of about three-eighths of an inch. This tool, if used as a cold chisel, is less likely to cut into the sheet. It is also a good plan for a helper to buck the rivet from the inside, especially if the rivet is in thin sheeting. The head having been knocked off, the shank of the rivet can be knocked out with a punch. If the float has been painted several times, it is best first to remove the paint around the rivet head so that the work can be seen better.

"An excellent precaution to take before attempting to knock off the head of a rivet is to drill some distance into the head

with a drill somewhat smaller than the shank. This weakens the head and it can then more easily be removed. To properly start the drill, a center punch mark should be put in the center of the rivet head. Great care should be taken not to drill completely through the head for fear of injuring the sheet, for even by starting the drill from a centre punch mark, it is very difficult to drill down the shank without penetrating through the side. With a little practice, however, particularly if an electric drill is available, it is very easy to weaken the head and then knock it off with a cold chisel without in any way damaging the metal or enlarging the rivet hole.

"**Driving Rivets.** If the rivets have been removed carefully, the same sized rivet as used originally can be replaced in the holes. The shank of the rivet should project out a distance equal to about 1½ or 2 times its diameter. In the factory, the large assortment of rivets makes it possible to have the proper length on hand at all times. In the field, however, it will usually be necessary to use long rivets and cut off the shank to the required length with a pair of cutting pliers or small tin shears. The rivet is normally put in and bucked from the inside, so that the head is formed on the outside, and it is well to daub the hole with Bakelite Seam Compound to prevent leakage and corrosion. Until experience has been gained, the rivet should not be set too tight. A loose rivet can be tightened but too much hammering may injure the sheets, causing dents and tending to expand the metal so that it bulges out between rivets.

"There are two essentials in properly driving rivets. In the first place, the bucking bar must be really pressed and held tightly against the rivet. It is sometimes difficult to see whether the bucking bar is up tight; in such case the man on the outside should check it by trying to push the rivet in before he starts putting a head on it. In the second place, the sheets of metal which are being riveted must be drawn tightly together before riveting is started. This can be accomplished by the free use of machine screws in preliminarily clamping the sheets together.

"If many rivets are to be put in, a special draw set can be used to advantage. This is essentially a rod with a hole drilled in one end to a size 1/32″ larger than the shank of the rivet and short enough to expand the head of the rivet at the same time

that it draws the metal together. After the rivet has been placed in the hole and bucked, a few blows are given with this tool before driving it. If the rivet is properly driven and the sheets drawn together, a water tight joint is assured. If the sheets are not drawn together, the shank of the rivet will expand between the sheets, and although the rivets may look all right from the outside, water will leak in between the sheets.

"It is advisable to use a rivet set to put the head on the shank of the rivet, and it is important to hold it parallel with the shank or else a defective head will be formed. Eight or nine blows with a medium weight hammer on the set should be sufficient to form a good head. There are a few awkward places in the float where it is very difficult to insert a rivet from the inside. In these cases insert a wire through the hole in the float from the outside. This wire can be fastened to the rivet by filing a point on the rivet and drilling a hole through the narrow part. The point of the rivet is then drawn through the hole by pulling on the wire. Do not unfasten the wire until sure that the rivet is properly bucked from the inside.

"Where compressed air from 80 to 150 lbs. pressure is available, a Type "U" Boyer compressed air scaling hammer, costing about $45 and obtainable from the Chicago Pneumatic Tool Company, will drive rivets in about half the time required by hand. In this case, the rivet is pushed into the hole from the outside and the hammering is done against the head of the rivet. The pushing up of the bucking bar against the shank of the rivet forms a head on the inside. This type of hammer requires care in handling and is not recommended unless extensive rebuilding work is to be accomplished.

"**Straightening Dents.** If a float has been slightly dented it can be hammered back into shape by placing a flat piece of wood against the deformed part and hammering on the projecting material with a wooden mallet. A stick of wood pounded with a hammer will often reach spots where a mallet cannot be used. Where dents have produced very sharp bends in the metal, they can still be hammered out; but in this case it is advisable to reinforce them by putting on a patch (as described in the next paragraph "Patching"), even though the flattening out of the metal has not caused any apparent cracks.

"As previously noted, the portion of the bottom just forward

of the step plays a most important part in the take-off characteristics of the floats, and if it is even slightly dented or deformed, it may make itself felt by a tendency to porpoise or nose over in high speed conditions on the water. For this reason, even small dents must be corrected in this area, but with this exception it is probably better to leave them alone, since hammering changes the molecular structure of the metal, weakening it, and making it more subject to corrosion; therefore in the absence of heat-treating facilities as little should be done as possible.

"**Patching.** Welding any part of the floats must be absolutely prohibited since it is extremely difficult to accomplish, and at the same time it would destroy the strength of the heat-treated metal as well as the alclad protective film. Hence where the metal has been cracked, punctured, or requires reinforcing, a patch is always applied, and the operation should be performed with care.

"Never try to patch over a dented or torn piece of metal until it has been hammered back into shape, as described above. Before making a patch the paint should be removed and the region of the damage carefully examined for cracks or tears radiating from the edges. These should all be cut away. Having determined the extent of the damage, the edges should be trimmed out with shears or a hack saw so as to form a symmetrically shaped hole with sound metal all the way round, and carefully smoothed down with a file.

"The next step is to cut out a patch large enough to overlap the edges of the hole by approximately 5/8″ all the way round, using alclad sheet, one or two gauges heavier than the damaged material. A row of rivet holes should then be laid out and centre punched on the patch, 1/4″ in from the edges of the patch with a spacing 3/8″ on centres. Unless the material is over .040″ thick, rivets of 1/8″ diameter should be used; for heavier gauges 5/32″ rivets should be used.

"To apply the patch, three or more holes should first be drilled through both the patch and the piece under repair, and machine screws put in so as to hold the patch in place until the balance of the drilling and riveting is completed. Be sure and have the patch set firmly against the float before drilling; otherwise they are likely to be found out of alignment when riveting is started. The patch should always be applied from the out-

side, and drilling will be greatly facilitated if a block of wood is held against the metal from the inside. To insure water tightness and prevent corrosion, cotton cloth or seam tape, thoroughly soaked in Bakelite Seam Compound should be placed between the patch and the metal under repair. This same procedure should be followed in making up any other water tight joints or seams in the repair of the floats, and although the cotton is omitted in non-water tight joints (such as auxiliary framing between bulkheads), the surfaces should nonetheless be painted with seam compound before riveting in place.

"**Patching with Screws.** Where rivets are not available or where because of lack of time or facilities it is impractical to use them, Parker Kalon thread-cutting metal screws or steel-machine screws may be used for temporary repairs. Both are put in with heads on the outside and can generally be purchased from any hardware jobber. Since Parker Kalon screws are set with a screw driver they have the advantage of not requiring any attention from the inside of the float, which is of great value in emergency use and where difficult spots must be reached. It is very important, however, to *use exactly the right size drill* before setting them in place, since otherwise their effectiveness will be much impaired; and for this reason a special drill of the correct size is included in the standard Edo repair kit. The correct size will also generally be found marked on the box of screws. They should be long enough to protrude through the sheets with one thread showing. Both machine and Parker Kalon screws are, of course, only temporary and should be replaced with rivets at the first opportunity.

"**Removing Decks.** Removing the decks gives good space to work in and often means quicker and better results in case of a general overhaul or major repairs. It is accomplished by knocking out the rivets, and where the damaged area is localized, it may save time to remove only the section of deck between two bulkheads. This is done by cutting the deck sheet with a drill and hack saw. To make the cut strong and water tight when replacing it, an extra strip about 1½" wide is lapped over the joint. In the shop two men can generally remove the decks of an average size pair of floats in a morning and put them back in a day.

"The same holes are used in putting decks back. The rivets

fastening the deck to the stringers and bulkheads are put in and bucked from the inside by reaching through the hand hole covers and riveted in the usual manner. In case of floats having an outside seam, however, the rivets can be squeezed with a considerable saving in time. A large wire cutter about three feet long with specially cupped jaws can be used for the purpose. Such a tool can be supplied by Edo for about $25 or made up at any machine shop.

"Special precautions must be taken in removing and replacing decks on those float models in which the spreader tubes are attached to the upstanding seams in order to be sure that the strength of the fitting is not impaired. The danger lies in improperly replacing the steel "U" clip, and every effort should be made to use the original holes for the rivets, because drilling new holes would seriously weaken the vertical stiffener. If new deck and side sheets and vertical stiffeners are used, it is extremely important to see that the "U" clip is driven firmly home before drilling; otherwise the holes might only pierce the edge of the metal, resulting in a complete loss of strength in tension.

"**Replacing Sheets.** Where a large area is damaged, it makes a better job to remove a section of the sheets instead of trying to put in a very large patch. Such a replacement should extend at least the length between two bulkheads, and the joints should be made at the bulkheads rather than between them. In splicing on a new sheet a double row of rivets should be used on the bottom, although a single row will suffice in the side. In most cases it is easier to put both rows on the flanged side of the bulkhead. Although it takes more time, it makes a better job if a reinforcing strip is put on the inside of the bulkhead flange. It is very important that the old holes in the original metal match exactly with the holes drilled in the replacement sheet or patch. Otherwise, if new holes are drilled between the old holes, it will so weaken the sheet as to seriously affect its strength.

"To insure matching of the holes, either drill the patch from the inside using the old holes as a guide, or mark the patch very carefully with a pencil so that the centre of the mark is exactly over the centre of the hole. In thin sheets, where a drill will not reach a hole from the inside, it is possible to push a sharp instrument, such as an ice pick or centre punch, hard up against the inside of the sheet. By hammering lightly on the outside of the

sheet with a mallet, a slight projection results which can serve to locate the hole.

"**Repairs of Buckling—Internal Failures.** If the side sheets have been slightly wrinkled by very hard landings, they can be bumped out by bracing the outside of the float at the bulkheads and hammering from the inside with a board hit by a wooden mallet. The stringers can generally be straightened in the same manner, and it is then advisable to rivet some extra ones on the inside to keep the damage from spreading. If the float is buckled to a point where there is a sag of more than one-quarter of an inch in the deck line or the bottom stringers in the flat portion of the step, or if the side sheet wrinkles are very sharp, it will probably be necessary to remove the deck in order to make a thorough inspection and replace those stringers which are bent.

"There is also a possibility that the sheets will have been strained so that they may crack when straightened. If this is the case, it is generally advisable to remove the damaged ones and splice on a new section.

"In the case of a float which has been seriously buckled, the bulkheads should also be carefully examined for buckling or cracks particularly at the bottom, near the flange. If the buckle is not bad, it can be hammered out and a reinforcing plate fastened on. This should usually be flanged over and fastened on the opposite side from the existing flange. If the buckling is so bad that the bulkhead has cracked, it is advisable to saw out the bottom half and rivet on a new portion. Bulkheads of production floats are generally stamped at the factory to standard sizes, and it is usually easier and cheaper to obtain a new one than to try and form one. Except in cases of minor buckling, it will generally be necessary to remove the bottom as well as the deck in order to properly replace a section of bulkhead.

"**Repairs after Serious Crashes.** So long as either the deck or the keel of the floats remain straight and the whole structure has not been buckled, repairs in the field can generally be made as described in the previous paragraph. A pontoon which has actually been buckled in a crash, however, is very difficult to repair without replacing it on an assembly jig, since a whole section will probably have to be removed. If the damage appears to be of such a very serious nature, it is advisable to have photographs taken from several angles and sent to the Edo fac-

tory with as complete a description of the damage as possible, so that detailed advice can be given.

"Sometimes as a result of a serious crash, or where the propeller has cut through the float due to a strut failure, it is found that the bow of the float is hopelessly damaged, whereas the rest of it is in excellent condition. In cases of this sort it is frequently practical to cut away the entire damaged portion and splice on a new section supplied from the factory.

"**Repairing Struts.** In the case of crack-ups where struts and spreader tubes have been damaged, the struts themselves can generally be repaired by welding on reinforced sleeves or patches of ordinary aircraft sheet steel or tubing; but it is important to be sure that repaired struts are oiled inside, drained, and hermetically sealed so as to prevent internal corrosion. The spreader tubes, however, are generally made of dural or chrome-moly steel tubing which has been subjected to heat-treatment, and in a number of cases certain struts have been designed in the same manner. Obviously, such parts cannot be welded without destroying their strength and factory replacements are generally required. For these reasons it is advisable to secure advice from Edo or an authorized representative before attempting strut repairs."

APPENDIX

Typical Float Specifications

(a) Model Number	(b) Weight in lbs.	(c) Weight in lbs.	(d) Weight in lbs.	(e) Compartments	(f) O. A. width	(g) O. A. length	(h) Tread	(i) Maximum draft
1070	600–1020	1125	106	4	90″	12′ 3″	66″	11″
1620	1000–1440	1620	180	5	112″	14′ 6″	85″	14″
1965	1440–1765	1965	200	6	112¼″	16′ 6″	85″	14½″
2425	1765–2205	2425	230	5	123″	17′ 0″	94″	16½″
2880	2205–2630	2880	260	6	123″	19′ 0″	94″	16½″
3430	2400–3300	3610	313	5	132½″	19′ 4″	100″	18½″
4000	3300–3800	4210	363	6	136½″	21′ 4″	104″	19″
4665	3800–4400	4910	397	6	143½″	20′ 9″	106″	21″
5400	4400–5300	5680	417	6	145½″	21′ 9″	108″	22″
6235	5300–6200	6560	437	7	149½″	22′ 9″	112″	23″

Note:

(a) The model number indicates the total submerged displacement of *one* of the twin floats.
(b) Recommended for ships within this weight class as *land planes* with gross load.
(c) Maximum allowable weight as a *seaplane* with gross load, according to U. S. Bureau of Air Commerce Regulations.
(d) Average total *net weight added* by float gear, including water rudders, after *deducting weight of wheel landing gear and tail wheel.*
(e) Total number of water-tight compartments in each float.
(f) Over-all width of complete float gear.
(g) Over-all length of each float, not including water rudders.
(h) Tread between center lines of floats.
(i) Maximum draft with gross load.

GLOSSARY

Amphibian. An airplane designed to rise from and alight on either land or water, that is to say, equipped with both a means of flotation and a set of landing wheels.

Beaching gear. A device, usually including two or more wheels, designed for handling a seaplane or flying boat while on shore.

Beam. The transverse dimension of a float or hull.

Bulkhead. A partition in a float or hull. (See Figs. 57 and 58.)

Buoyancy. The weight of the liquid displaced by a floating or submerged object. *See* also *centre of buoyancy, excess buoyancy,* and *displacement.*

Catapult. A device for launching an airplane into the air, used almost entirely for seaplanes and flying boats.

Centre of buoyancy. The centre of gravity of the displaced liquid, which corresponds to the centre of the upward forces on a floating or submerged object. Abbreviated, *c. b.*

Chine. The corner between the side and bottom of a float or hull. (See Fig. 57.)

Dead rise. The difference in height between the chine and the keel at any given cross section. (See Fig. 57.)

Deck clamp. The longitudinal member joining side and deck skin.

Displacement. The volume or weight of the water displaced by a float or hull. *See* also *reserve displacement* and *submerged displacement.*

Dolly. A handling truck for an airplane.

Excess buoyancy. The difference between the displacement of a float or hull when under normal load and when submerged. Usually expressed in percentage of the buoyancy when under normal load.

Fin area. The area in a vertical plane of any portion of the airplane. *See* also *lateral fin area.*

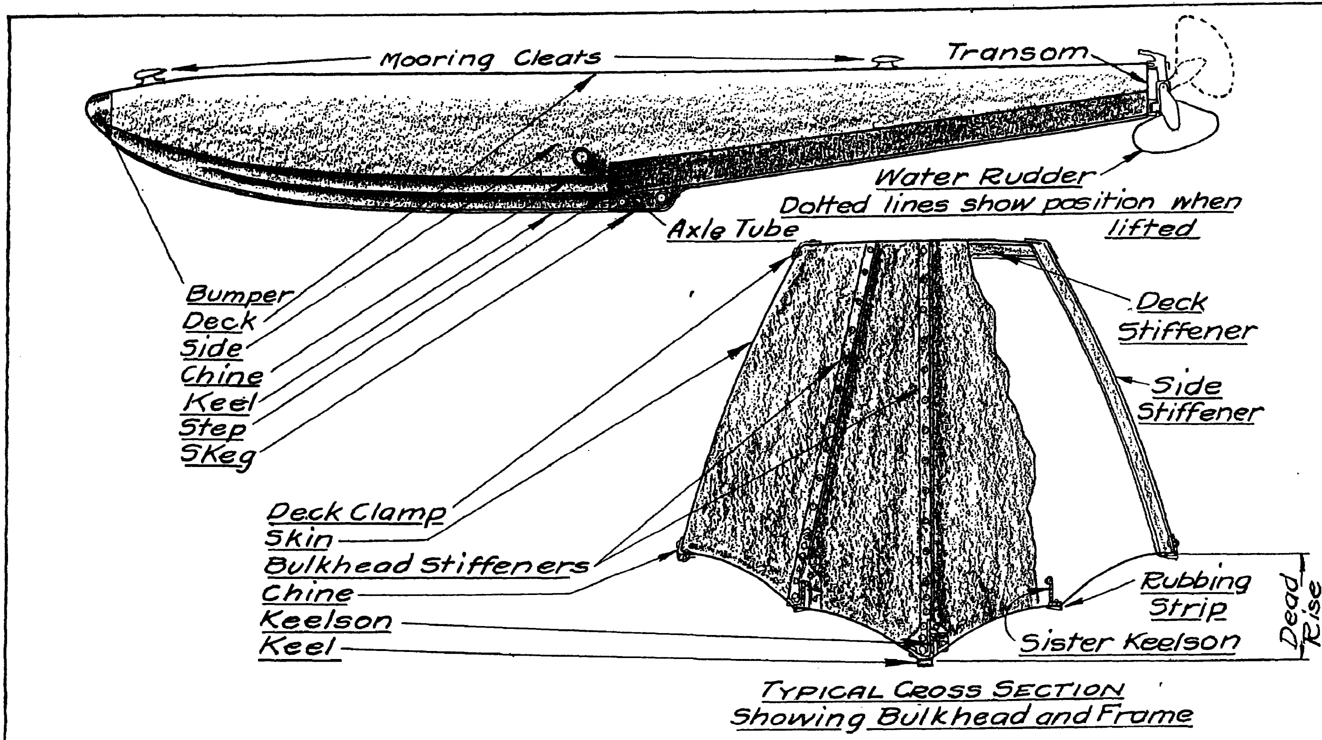
Float. A completely enclosed watertight structure attached to an airplane to provide buoyancy.

Flotation. Sometimes used instead of the word buoyancy.

Flying boat. A type of airplane in which the main body or hull, in addition to carrying the crew and payload also provides the main means of flotation.

Frame. A structure designed to support the longitudinal members of a float or hull, but not constituting a partition. *See* also *bulkhead* and Figs. 57 and 58.

Hull. That portion of a flying boat which provides the flotation and also, as a rule, accommodations for passengers and crew.


Mooring Cleats
Transom
Water Rudder
Dotted lines show position when lifted
Axle Tube
Bumper
Deck
Side
Chine
Keel
Step
Skeg
Deck Stiffener
Side Stiffener
Deck Clamp
Skin
Bulkhead Stiffeners
Chine
Keelson
Keel
Rubbing Strip
Sister Keelson
Dead Rise
Typical Cross Section
Showing Bulkhead and Frame

Hump speed. The speed during the take-off of a seaplane or flying at which the resistance of the float or hull reaches a maximum.

Keel. The external longitudinal member in the centre of the bottom of a float or hull. (See Fig. 57.)

Keelson. The internal longitudinal member in the centre of the bottom of a float or hull, to which the keel is attached. *See sister keelson* and Fig. 57.

Lateral fin area. The side area or the area of a vertical longitudinal section of an airplane.

Leeward. Away from the wind, down wind. Pronounced "loo-ard."

Load water line. The water line when the seaplane is carrying its normal load. Abbreviated, *L.W.L. See* also *water line.*

Plane (verb). To move on the water at such a speed that support is derived from the dynamic forces of the water rather than from the buoyancy of the moving object.

Porpoise. To oscillate about the transverse axis, or rock up and down while on the water.

Pusher. A type of airplane in which the propeller is mounted behind the engine. Also used in referring to the propeller itself when so mounted and, sometimes, to the engine.

Raft. As used in this book, a floating landing-stage or platform.

Ramp. As used in this book, a platform or structure sloping from land into the water.

Reserve displacement. The difference between the displacement of a float when carrying normal load and when totally submerged.

Sea-wings. Relatively short projections built onto the sides of a flying boat near the water line to provide lateral stability while the ship is afloat. Their section roughly resembles that of an airfoil, hence the name.

Ship (noun). As used in this book, a colloquialism for airplane.

Ship (verb). To take on board, as "to ship water over the bow."

Skeg. A member installed as part of the keel just aft of the main step on a float to protect the bottom and prevent the ship from tipping back when on land. (See Fig. 57.)

Skin. The covering of the frame of float or hull which makes it a watertight shell.

Sponson. A longitudinal protuberance on the side of a hull intended to increase the width of the bottom or improve lateral stability in the water.

Spreader bar. A horizontal transverse member running from one float to the other in a twin-float seaplane.

Step. An abrupt break in the bottom line of a float or hull to lessen suction, assist planing, and improve longitudinal control while the ship is moving through or on the water. (See Fig. 57.)

Stringer. A longitudinal structural member in float or hull. (See Figs. 57 and 58.)

Submerged displacement. The volume or the weight of the liquid displaced when an object is completely submerged.

Figure 58. Float Under Construction

Tractor. An airplane in which the propeller is mounted in front of the engine, or the propeller itself when so mounted. This, of course, does not apply to the farm tractor used for towing purposes.

Transom. The approximately vertical bulkhead at the stern which terminates a float. (See Fig. 57.)

Tread. The horizontal distance between the centres of the floats in a twin-float seaplane.

Trim. The angle between the horizontal surface of the water and the float or hull.

Water line. The line made by the horizontal surface of the water on the float or hull when afloat. Abbreviated, *W. L.*

Weathercock. To point into the wind.

Windward. Toward the wind, up wind.

Yaw. To swing to one side or the other, rotating about the vertical axis.

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